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THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN; THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION, AND THE FOUNDRY TRADES EQUIPMENT AND SUPPLIES ASSOCIATION.

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Forthcoming Events.

Institute of British Foundrymen.

APRIL 5.

Lancashire Branch:—Annual business meeting at Manchester. "Foundry Organisation," Paper by J. Yates.

APRIL 6.

West Riding of Yorkshire Branch:—Ordinary meeting at Bradford.

The Balfour Report—I.

The final report of the Committee on Industry and Trade, known as the Balfour Committee, has just been issued, and we think that we can most usefully serve the trade by putting forward those parts of this very comprehensive document (it runs to over 300 pages) which are likely to affect it. It will be recalled that the Committee was appointed in July, 1924, by Mr. Ramsay MacDonald during his tenure of office as Prime Minister. It was charged to consider the general question of British overseas trade, the ability of British industries to adapt themselves to the new conditions of world competition and the general influence on these matters of relations between capital and labour. The Committee has thus been at work nearly five years. In the scope of its inquiries, the evidence available to it and the responsibility behind the evidence, its conclusions must approach in value those of a Royal Commission. The Committee, however, is predominantly industrial in character, and consequently its conclusions must not be regarded as academic but as the most considered opinion of a group of men of diverse interests (capital and labour were both represented on the Committee) to their colleagues in industry, all over the country, in the light of a mass of evidence, much of which for obvious reasons cannot be put before the general public.

As an indication of the magnitude of the task, it may be mentioned that the Committee has had 136 meetings apart from Sub-Committees, and examined 240 witnesses as well as many Government officers. Six lengthy reports have already been issued, and those appropriate to the metal industry have already been commented on in these columns. Among these were the "Survey of Overseas Markets" and the "Survey of Industrial Relations." Then we had two reports surveying factors in industrial and commercial efficiency, while the remaining two dealt with the special problems of the textile and metal industries. Of these reports nearly 22,000 copies have been prepared for use.

Considering the varied composition of the Committee, the unanimity of the conclusions drawn is extraordinary, and well exemplifies the fact that any reasonable man approaching the problem in the light of all the evidence available, comes in the main to one set of conclusions. The absence of striking cleavages of opinion reinforces, if any reinforcement were necessary, the desirability of all business men acting on the recommendations. We, therefore, propose to consider in subsequent issues the leading recommendations in so far as they bear directly on the engineering and foundry trade. This can be done conveniently by considering them in relation to overseas trade, labour conditions, matters affecting competitive efficiency, such as standardisation, education, research and salesmanship, and finally the incidence of public charges, such as income tax, rates and so on.

Electric Heating Problems.

As a pioneer of the electric furnace industry, it is with a certain amount of satisfaction that we note the distinct technical and industrial progress that is now being attained. The electrode melting furnaces are now, in their larger sizes, being machine-charged; electrode and current consumptions have been materially reduced, whilst life of roof and hearth correspondingly increased. The mechanical equipment, too, has been made reasonably foolproof.

A post-war development of outstanding importance has been the introduction of the high-frequency furnace. We hear of one installation making 7 tons of nickel-chrome alloys a week, and the astounding feature of this is that a large proportion of its output is being consumed by the heating elements in large electrical resistance furnaces. Early this week we spent some time in one of the best equipped heat-treatment shops in Great Britain. Here resistance furnaces, having a temperature control within 3 deg. Centigrade are said to be operating more cheaply than when using town's gas. Some of these furnaces have a hearth area of more than 5 ft. square, yet one can approach them without noticing any appreciable increase in temperature, so efficient has been the insulation. When one takes into consideration that there is no chimney, a perfect temperature regulation and exceptionally good insulation, it is fairly obvious that the limit of industrial efficiency has been reached so far as the furnace itself is concerned. Inefficiency is confined to the process of generating electricity from the combustion of coal and its losses in distribution, for we can conceive of no furnace which better conserves its heat in what the French aptly call the "laboratory." If this type of furnace can be operated so as to avoid rapid changes of temperature—which should not exist in such large well-insulated industrial units—we are informed by a commercially disinterested expert that the elements should last two years, mechanical accidents apart. These furnaces are, of course, fairly expensive to install, and complete running costs are not yet available from the plant we have in mind, and even when they are forthcoming, it will not be too easy to translate the figures into terms comparable with those wanted for the foundry industry. However, on leaving this heat-treatment shop we drew the following conclusions. Sooner or later these resistance furnaces will become of distinct commercial interest for annealing malleable iron castings, and at a considerably reduced efficiency for core baking and mould drying. As a metallurgist, we inherently detest this latter problem, as it more closely resembles the family wash-day proposition than one of efficiently communicating a certain number of heat units to a mass of

material in a predetermined time to accomplish a desired result. Core drying involves the reasonably rapid changing of steam- or gas-ladened atmospheres every so often, which obviously means the escape of perfectly good heat units into the chimney or atmosphere. Thus we see less prospect of the application of resistance furnaces for core drying than for malleablising.

The Development of Nickel.

There was a big gathering of students at the Nottingham University College on March 15 to hear Professor F. S. Kipping speak on "Evolution in Chemical Industry; Nickel and its Uses."

He said that, in spite of the fact that articles composed partly of nickel had been used for thousands of years, it was not until 1751 that nickle was recognised as a separate entity. Its manufacture involved a series of operations in which nickel had to be separated from the earthy matter combined with other metals present in the ore. Embarassing difficulties had to be overcome, and it was in 1830 that the manufacture of the metal was employed for the first time in Saxony. In 1880 ores were discovered in Ontario.

The world's consumption of nickel in 1900 was 5,000 tons, and by 1915 had risen to about 30,000 tons a year. This increase was accompanied by improved methods of manufacture. New uses for nickel also were evolved by chemists and engineers. The war period witnessed another great jump in the manufacture of nickel, because of its value in the production of armaments. After the war came a slump, and nickel manufacturers did not know what to do with their metal. New applications for its uses, however, were brought forward, with the result that now 50,000 tons were annually employed. Of this total, he was glad to say that about 90 per cent. was produced from the mines in Ontario in the British Empire. He made a number of experiments, and declared that the discovery by Dr. Ludwig Mond, father of Lord Melchett, revolutionised the manufacture of nickel, for before then it was not known that nickel and carbon monoxide would combine. Having mentioned various uses to which nickel could be put, Dr. Kipping went on to mention the part it played in cheapening the manufacture of margerine, etc. Twenty or thirty years ago a French chemist, who made certain experiments with nickel, found that it had the property of causing substances to combine with hydrogen, and later investigations showed that the liquid oils could be converted into solid fats by a similar process.

A number of lantern views of nickel mines in Canada and the Mond Nickel Works, near Swansea, were screened.

A Workers' Committee.

At a meeting of the employees of Messrs. John G. Stein, Limited, Castlecary Fireclay Works, held recently, a proposal was submitted and unanimously agreed to that a workers' committee be formed at Castlecary works. Colonel Stein, who presided, outlined the objects of the scheme, and made reference to several works where such a scheme was in operation. Mr. Taylor, Mr. Bain and himself had visited different places where the scheme had been adopted and seen what had been achieved. A committee was appointed to draw up a constitution suitable to Castlecary works, and departments would nominate representatives to the committee.

An Echo of the B.I.F.

On page 174 we described how the Pneulec Company were honoured by a visit of H.R.H. the Duke of York to their stand at the British Industries Fair. We are now in a position to

record this interesting event by the accompanying illustration, which shows His Highness as an interested spectator. It is well known that as a naval cadet the Duke had some practical experience of moulding and foundry work.

Works of Guest, Keen & Nettlefold Visited by Wales and Monmouth Branch of the I.B.F.

On March 16, members of the Wales and Monmouth Branch of the Institute of British Foundrymen visited the Cwmbran (Monmouth) works of Messrs. Guest, Keen & Nettlefold, Limited.

The party were conveyed to the works by a special bus, and first inspected the coke ovens. Mr. J. P. Bayley and other members of the staff explained the method by which these, and also the coal washing and crushing plant, were operated. The conveyors which carry the coal to the ovens were also inspected, and demonstrations given of charging and discharging. The tar and by-products distilling plant proved interesting.

A tour was made of the foundry, which is noted for its output of railway chairs and other rolling-stock castings.

After tea, which had been provided at the Half Way Hotel, the Branch-President, Mr. R. G. Williams, thanked the management for their hospitality and a most interesting afternoon. The Hon. Secretary, Mr. McClelland, seconded this vote.

Mr. Bayley, replying, expressed his own views on the conditions prevailing in the foundry trade at the present. He was delighted that all had spent an enjoyable afternoon.

In the evening, Mr. H. E. Taylor, B.Sc., A.I.C., presented a Paper on "The Production of Foundry Coke" to the members, at the Technical College, Newport.

The Railway Clearing House has issued an addendum (P.O./C.L. 36) to the specifications and drawings for standard 12-ton and 20-ton mineral wagons, and cylindrical tank wagons. It provides, *inter alia*, in addition to existing regulations, that tyres and axles must be stamped with the following letters according to the class of steel used in their manufacture:—Acid open-hearth steel, A.O.H.S.; basic open-hearth, B.O.H.S.; acid Bessemer (tyres only), A.B.S. The maximum tares (with side, end and bottom doors) for standard 20-ton mineral wagons are now as follow:—Wood body, 9 tons 10 cwts.; metal body, 10 tons. Various alterations in constructional details have been made, a number of which are illustrated in the addendum. Copies of the addendum are obtainable from the Railway Clearing House, price 6d. each.

Random Shots.

We have had just a week of spring following one of the most calamitous and uncomfortable winters in my experience. It crowned its length by a severe patch which dislocated traffic and consequently industry all over Europe to an unprecedented degree. It provided a week-end of sudden sunshine which made us think of July and then plunged us into an influenza-pneumonia epidemic. No, the winter of 1929 has gone to its overdue grave unwept, unhonoured and unsung. The only redeeming feature has been the performance of the English team in Australia.

* * *

I noticed an Englishman abroad writing to a daily contemporary suggesting that the French had withstood the influenza epidemic, which had ravaged Europe and America, better than any other nation. Now in the ordinary way you would think that a nation addicted to outdoor sports and fresh air, such as the English people are, would make a better showing than a nation which admittedly is much less keen on outdoor sport, physical exercise and fresh air.

* * *

The man in question put the French immunity down to the fact that they live more naturally than we do. They eat more than we do, of better cooked food, they are less faddy, and have what they want. On the other hand he thinks we pay too much attention to the "new health" faddists and the people who are always telling us we eat too much and smoke too much and worry too much and so on. It is a queer business. So far as my personal experience goes it doesn't seem to make much difference whether you are a total abstainer or not, or non-smoker or not, an ardent physical-culturist or not. Perhaps moderation and common sense are best, coupled with a certain amount of good luck, if you want to live to a ripe old age. Of course the recipe of the next centenarian will probably cancel out the advice of the last.

* * *

Anyway, we are all looking forward to the spring. Easter lies immediately before us, the boat race came off last Saturday, the Grand National the day before, and very soon there will be the Cup Final. What are the chances of a tussle between Portsmouth and Bolton at Wembley?

* * *

I hear that the informal luncheon preceding the Annual Meeting of the Foundry Trades Equipment and Supplies Association on March 14 was a cheery affair, and that the credit for the conception and a good deal of the organisation of the visit of British industrialists to Russia which you have read so much about in the papers recently, has to go to those behind the scenes in the foundry trade.

* * *

Here is a little story that will appeal to salesmen. A traveller tried many times to get an order out of a certain business man and never succeeded, although the latter was always ready to have a yarn. After another unsuccessful visit the traveller was departing hurriedly when the man asked if he hadn't something fresh to tell him. The traveller thereupon related a dream he had had the previous night, about going to Heaven and St. Peter giving him a very fine cigar and showing him the wonder of Heaven. When he had finished his cigar he asked St. Peter where to throw the butt, as he did not wish to soil the golden floor. He was shown a little hole in the floor, but chancing to look through, happened to see his prospective customer, Mr. Brown, immediately underneath. He said to St. Peter, "I cannot drop my cigar end through that hole for it is right over the office of my friend Mr. Brown, and I don't want to burn his eye out." "Why not?" said the saint. "He never gives you an order, does he?"

Marksman.

The Annealing of Cast Iron.*

By H. H. Beeny, M.Met.

Much work has been done at one time and another in various countries on the annealing of cast iron, and the general facts in regard to its influence are well known. Donaldson has very thoroughly dealt with the temperature range up to 600 deg. C., both in regard to the effect of temperature on the rate of decomposition of the pearlite and also from the standpoint of the stabilising action of various elements on the pearlitic carbide.[1] He has found that an ordinary foundry iron, containing 2.19 per cent. of silicon, actually can lose 0.2 per cent. combined carbon when heated for 200 hrs. at 300 deg. C., and the loss of combined carbon increases with increasing total carbon and silicon. Also the higher the temperature used for annealing, the swifter the decomposition.[2] The action of silicon at these, as at higher temperatures, is very marked, and low-silicon irons, such as "Perlit," with approximately 1 per cent. of silicon, retain the bulk of their combined carbon even after prolonged annealing at 550 deg. C.

It is interesting to note that combined carbon can be lost at such low temperatures, and for certain classes of work the stability of the iron within this range is of first importance. Deliberate annealing does not, however, usually commence below about 600 deg. C. This temperature is useful for relieving strains, as, given only a few hours' treatment, the loss of combined carbon and associated properties, in even the higher silicon irons, is negligible. The region of temperature up to 870 deg. C. has been usefully surveyed by Coyle.[3] Irons of the following general composition were used:—Total carbon, 2.95 to 3.20 per cent.; silicon, 1.00 to 1.30 per cent.; manganese, 0.30 to 0.50 per cent.; sulphur, 0.12 per cent. max.; phosphorus, 0.20 per cent. max. Fig. 1, reproduced from his Paper, summarises the effect of heating for one hour at differing temperatures, followed by quenching in water, upon the combined carbon and tensile strength of two irons "A" and "B." The iron "B" was higher in silicon than "A." At 650 deg. C. very slight reduction of combined carbon occurs, but the loss rapidly increases with temperature until at 750 deg. C. it reaches a maximum. Combined carbon becomes again more and more stable on raising the temperature up to the highest given, which is 870 deg. C. It is interesting to see how closely the combined carbon and tensile curves agree. There is much in common between these experiments and those described below, which were performed by the present author in 1925, but not previously published.

In the first place, only one iron was used, the "L/1" in Table No. 1, and this was studied microscopically, but an iron each higher and lower in silicon was later included for comparison.

The irons were cast in green sand, and were made into quite small pieces for the Brinell and other tests. After heating, cooling was allowed in air, but, owing to the small size, this would be quite rapid. Fig. 2 gives the etched struc-

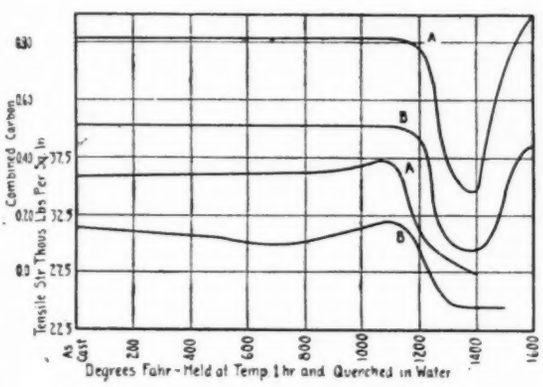

FIG. 1.—CHANGES IN STABILITY OF PEARLITIC CARBIDE AND TENSILE STRENGTH WITH TEMPERATURE (COYLE).

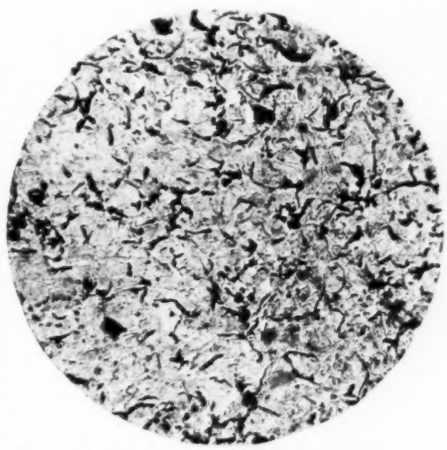

FIG. 2.—L/1 METAL AS CAST. ETCHED 2 PER CENT. HNO_3 IN ALCOHOL; × 100.

FIG. 3.—L/1 METAL ANNEALED 1 HOUR AT 750 DEG. ETCHED 2 PER CENT HNO_3 IN ALCOHOL; × 100.

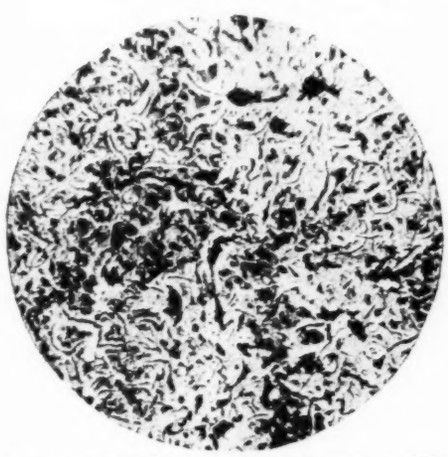

FIG. 4.—L/1 METAL ANNEALED 2 HRS. AT 830 DEG. C. ETCHED 2 PER CENT. HNO_3 IN ALCOHOL; × 100 DIAS.

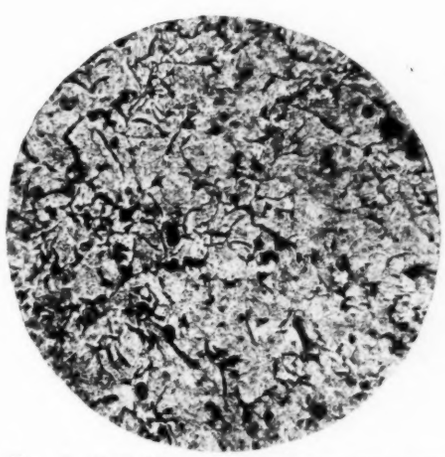

FIG. 5.—L/1 IRON FULLY ANNEALED AND THEN RE-HEATED FOR 1 HR. AT 870 DEG. C. ETCHED 2 PER CENT. HNO_3 IN ALCOHOL; × 100.

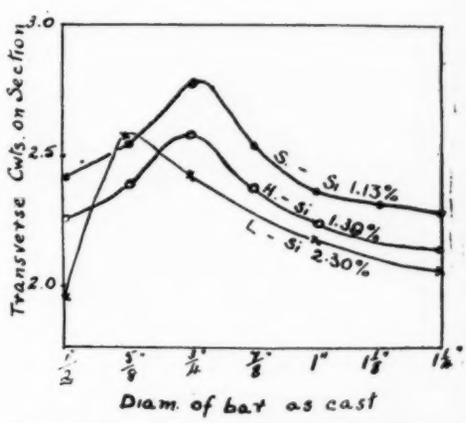

FIG. 6.—VARIATION IN STRENGTH WITH RATE OF COOLING—ALL BARS MACHINED TO 0.5 IN. DIA. FOR BREAKING.

* A Paper read before the London Branch of the Institute of British Foundrymen on March 14, Mr. Wesley Lambert presiding.

REFERENCES.

1 "The Heat Treatment and Volume Changes of Grey Cast Irons," between 15° and 600° C. F.T.J., 1928, Oct. 25, pp. 299, and Nov. 1, p. 315.
2 "The Heat Treatment and Growth of Cast Iron." F.T.J., 1927, Feb. 17 and 24.
3 "Properties and Heat Treatment of Cast Iron for Diesel Engines." Trans. Amer. Soc. for Steel Treating, 1927, Sept., pp. 446.
4 Trans. Amer. Soc. for Steel Treating, 1927, vol. 12, July, pp. 27–40.
5 Die Giesserei 1927, No. 46, pp. 849–854, and No. 50, pp. 865–870. Abstract F.T.J., 1928, March 15, pp. 191–92.
6 Foundry, 1920, March 1.
7 "The Influence of Composition and Rate of Cooling upon the Microstructure and Physical Properties of Cast Iron." F.T.J., 1924, April 24, p. 337.
8 British Standard Specification for General Grey Iron Castings, Grades A and C. No. 321, 1928, p. 11.
9 "Mechanical and Machining Properties of an Annealed Cast Iron." Trans. Amer. Soc. for Steel Treating, 1927, May, Vol. XI, pp. 741–759.
10 I.B.F. 1918, also "Metallurgy of Cast Iron," by J. E. Hurst, pp. 242–43.

ture of the "L/1" metal "as cast." The graphite flakes are small and a little ferrite is visible adjacent to some of them, otherwise the ground-mass is pearlite intermeshed with phosphide eutectic.

A temperature of 700 deg. C. was found slow in eliminating all the combined carbon. Fig. 3 shows the effect of one hour at 750 deg. C.; 800 deg. C. was similar.

The sample consists now of slightly enlarged graphite flakes with ferrite and phosphide eutectic. After two hours at 820/830 deg. C., 0.30 per cent. combined carbon remained, however (Fig. 4). This agrees with Coyle's curve (Fig. 1). Longer periods at this temperature were no more effectual. A state of equilibrium had been obtained. Next, samples of the "L/1" metal were annealed to remove all the combined carbon, and then re-heated for one hour at temperatures varying from 750 to 880 deg. C. Up to 800 deg. C. the structure remained as in Fig. 3, but in 880 deg. C. the structure in Fig. 5 was obtained. This is practically identical with Fig. 2, as the pearlitic matrix has been almost completely re-formed.

This work conclusively shows that pearlitic carbide is stable in certain irons at temperatures above approximately 800 deg. C. Returning to Table No. 1, it will be seen that the higher the silicon, the more rapidly and completely is the combined carbon destroyed by annealing, and that, once destroyed, with the highest silicons it is difficult or impossible to make it re-form.

Table I.—*The Influence of Annealing for 2 hrs. at Certain Temperatures upon the Brinell Hardness and Combined Carbon, per cent.*

Per cent.	"P/1."		"L/1."		"H/1."	
C	3.21		3.38		3.54	
Si	3.40		2.12		1.62	
Mn	0.51		0.51		0.54	
S	0.07		0.08		0.095	
P	1.08		1.00		1.08	
Condition.	Brinell hardness.	Combined carbon. Per cent.	Brinell hardness.	Combined carbon. Per cent.	Brinell hardness.	Combined carbon. Per cent.
"As Cast"	235	0.25	217	0.70	255	0.75
Annealed 700 deg. C. ..	197	Trace	—	0.20	174	0.35
„ 750 deg. C. ..	197	Nil	167	Trace	163	0.15
„ 830 deg. C. ..	201	Nil	—	0.30	197	0.60
„ 850 deg. C. ..	201	Nil	—	—	217	0.65
„ 870 deg. C. ..	—	—	212	0.60	—	—

Table II.—*Metal "L/2" (Table No. 4) Combined Carbon "as cast" 0.58 per cent.*

Oil quenched from. Deg. C.	Brinell as quenched.	Tempered at 600 deg. C.	
		Graphite. Per cent.	Combined carbon. Per cent.
750	179	3.22	0.03
800	187	3.14	0.11
850	269	2.74	0.51
900	363	2.55	0.70
950	444	2.50	0.75

The Brinell readings, which were made with the 1 m/m ball machine and 30 kgs. load, bear out the combined carbon figures.

A further experiment was put in hand in order to confirm the high carbon in Fig. 5 when compared with Fig. 4. Pieces of "L/2" grade metal (Table No. 4), which is an iron similar to "L/1," were held at temperatures ranging from 750 to 950 deg. C. for two hours, and then quenched in oil, Brinelled, and finally tempered at 600 deg. C. for drilling. The Brinell numbers and combined carbons are given in Table No. 2. The metal contained 0.58 per cent. combined carbon "as cast"; this falls to 0.03 per cent. at 750 deg. C., but gradually increases with the annealing temperature until actually by oil quenching more is preserved than in the "as cast" bar. The Brinell figures support the analytical results.

The foregoing results are in general agreement with those of Roth,[4] who states that 760 deg. C. produces the most rapid formation of graphite and that above this temperature, with air-cooling, the combined carbon is less and less broken down. The statement, when applied to foundry irons of widely different grades, as we have seen, needs some qualification in regard to the higher-silicon metal, and also, as later experiments will show 760 deg. C. is very inefficient for breaking down the massive carbide found in the chill of even high-silicon metal.

This same phenomenon of carbide reformation from iron and graphite has been noted in regard to black heart malleable cast iron. Thus, Quadrat and Koritta[5] have shown that the fully annealed iron containing only a trace of combined carbon, when re-heated above 800 deg. C., re-forms carbide in amounts increasing with temperature until at 950 deg. C. over 1.00 per cent. is in the combined form. R. S. Archer also testified to carbide re-formation in black heart iron.[6]

This matter of carbide stability above approximately 800 deg. C. has been carefully gone into, as it is the most important factor underlying grey cast-iron annealing. Excepting the tests on chill annealing, the experimental work which follows has been directed to control the combined carbon in some degree by choice of annealing temperature, and to observe the effect upon the physical properties.

Preliminary work was carried out to determine the best conditions for testing. Twelve bars were cast in green sand, 1⅛ in. dia. by 14 in. long, all in one box and fed from a central runner. They were all well moulded and sound, except for the usual slight pin-holes in the skin. The grade of iron was similar to the "H/2" metal in Table IV. Four bars were broken "as cast"; four turned to ⅞ in. dia., and four rough turned and ground to ⅞ in. dia. The transverse breaking loads and deflections are given in Table III. A Denison transverse testing machine was used for all transverse tests with 12 in. between supports.

Table III.—*Transverse Tests on un-machined and machined bars.*

Bar No.	Condition.	Dia. at fracture. Average in ins.	Transverse. Cwts.	Deflection in ins.	Mod. of rupture.
1.	As cast	1.141	25.3	0.13	25.9
2.	„	1.132	28.3	0.14	29.7
3.	„	1.142	27.0	0.15	27.7
4.	„	1.151	28.3	0.15	28.2
		Max. in ins.			
5.	Turned	0.877	14.4	0.19	32.9
6.	„	0.876	14.4	0.19	32.9
7.	„	0.875	14.1	0.19	32.2
8.	„	0.877	14.0	0.18	32.0
9.	Ground	0.875	14.3	0.19	32.6
10.	„	0.875	14.3	0.18	32.6
11.	„	0.875	14.5	0.19	33.1
12.	„	0.875	14.0	0.19	32.0

The unmachined bars show distinct ovality—this is a defect not at all easy to allow for mathematically. This error is quite overshadowed, however, by the skin defects which, while quite minute, give a lead for a crack to start on the side where the bar is in tension. The responsibility of the skin for the widely varying results is made quite clear by reference to the remaining eight bars, which show a uniformity worthy of steel testing. The unmachined bars show a lower modulus of rupture. It is quite certain that had unmachined bars been used in this research the data obtained would have been much confused, and the investigation itself probably ruined. Without wishing to be unduly dogmatic, it is the author's experience that unmachined transverse bars are quite unsuitable for research work. Considerations of expense may predominate in the matter of routine testing, or it may be desired to include in the test the qualities of the skin; these matters require consideration, but, even so, the advantages to be gained by using machined bars are very strong. One cannot hope to represent the strength of a casting absolutely by a test bar, but if this is machined one at least can fairly arrive at the strength and suitability of the metal.

The ground bars are very accurate in regard to size, but such accuracy is unnecessary, and turned bars carefully finished were adopted as standard for all transverse tests. The very smooth finish of the ground bars did not give any improved results.

Tests on conditions of loading in the transverse test were also made, but provided the loading was reasonably slow and steady, concordant results were obtained within quite wide limits of loading speed.

For the main research, irons of the compositions given in Table IV were used, and in each grade 12 bars, 1⅛ in. dia. by 14 in. long, were cast vertically in green sand. The bars of each grade were cast together in one box from a central runner. In this way an attempt at uniformity was made.

Annealing was carried out on the bars "as cast." Subsequently, as implied by previous remarks, the bars were turned down to ⅞ in. dia. and broken between 12-in. supports. Tensile pieces when required were made from the broken transverse bars.

The results of the annealing tests are embodied in Table V in order of their effect on the combined carbon. It will be noted that the most important tests were carried out in triplicate. This was deemed necessary, as cast-iron tests have a bad reputation on the score of reliability. A few isolated results could be misleading, but the figures in general show good agreement.

Table IV.—*Composition of Sand-Cast Bars.*

Percentage.	P/2	L/2	H/2	S/2
Graphite C ..	2.89	2.67	2.64	2.73
Combined C ..	0.38	0.58	0.64	0.76
Si..	3.57	2.68	2.17	1.29
Mn	0.76	0.67	0.65	0.59
S	0.082	0.119	0.138	0.125
P..	1.00	1.06	0.79	0.86

The average values obtained undoubtedly rest on a very firm basis.

The combined carbons were determined from drillings taken close to the transverse fracture. The figures represent the difference between total and graphitic carbon, but were checked by the colour method, and in some cases by microscopic observation also. The Brinell figure given is the mean from not less than two impressions on each of the bars. Thus the first Brinell figure in the table is the average of six separate impressions. The 1-mm. ball machine, with 30 kgr. load, was used and gave very consistent values. The actual annealing was carried out in a gas-fired muffle

furnace, and a standardised platinum platinum-rhodium thermocouple was inserted immediately over, and in some cases actually touching, the middle of the bars.

The tests again show the comparative stability of combined carbon at temperatures over 800 deg. C., and the relation of its amount to the silicon content. The combined carbon actually found when cold depends to a very considerable extent upon the cooling rate; thus the "L/2" metal quenched in oil from 850 deg. C. (Table II) contained 0.51 per cent. combined carbon, cooled in air blast 0.34 per cent., in still air 0.19 per cent., and furnace cooled from this temperature would contain a trace or none.

Below 800 deg. C. the decomposition of the pearlitic carbide is merely a matter of time. The lower the silicon the longer the time required. Micro-examinations were made of a number of these irons, but the changes follow the lines of those indicated by Figs. 2, 3 and 4 and the structures are not reproduced.

In 1924 the author[7] published the curves given in Fig. 6. This figure for similar grades of iron shows the changes in strength due to the rate of cooling when cast. With slower cooling within the range tried the combined carbons fell off only slightly, so that the loss of strength was due in the main to increased size of structure. It was in order to cut out variations in initial strength due to this factor that all the bars in the present tests were cast the same size, irrespective of composition. Fig. 6, which covers a fair range in regard to rates of cooling, brings out very clearly the weakening action of silicon. The bars now under consideration bring out the same feature.

A study of Table V will show that the chief significance lies in its action upon the combined carbon. In Fig. 7 the physical properties in the table are plotted against the combined carbon produced by various annealing treatments.

The falling-off of strength with loss of combined carbon is very marked. This feature is particularly in evidence with the S/2 metal, which contained the most combined carbon as cast. As the silicon increases the amount of combined carbon in the cast bar is naturally diminished, and the loss on annealing becomes less and less. As a consequence, fully-annealed bars of all grades tend to have the same tensile and transverse strength. The deflection, however, improves the lower the silicon content. One can draw the conclusion that, the rate of cooling when cast remaining constant, the combined carbon is of major importance in determining the strength of sand-cast bars, and that consequently the lower the silicon in an iron, the greater the weakening action of unsuitable annealing. High-silicon metal such as P/2 is weak to commence with, and shows but little fluctuation in properties on annealing.

TABLE V.—*Changes in Combined Carbon Per Cent. and in Physical Properties due to Four Types of Annealing Treatment.*

Annealing Treatment	Grade.	Combd. Carbon %	Transverse Test. Breaking Loads Cwts.	Average Cwts.	Defl. in ins.	Mod. of Rupture Tons/□"	Brinell Hardness	Tensile Test. Breaking Loads. Tons/□"	Average Tons/□"	Modulus Tensile.
As Cast [A]	P/2	.38	10.6, 10.2, 10.1	10.3	.16	23.5	229	9.9, 11.0, 10.8	10.6	2.2
	L/2	.58	13.6, 12.8, 12.6	13.0	.16	29.7	241	12.8, 14.4, 14.4	13.9	2.1
	H/2	.64	15.0, 14.8, 14.7	14.8	.19	33.8	255	15.4, 17.0, 16.6	16.3	2.1
	S/2	.76	13.9, 15.8, 14.8	14.8	.22	33.8	241	15.7, 16.2, 16.7	16.2	2.1
3 Hours at 850°C – Cooled in Air Blast [D]	P/2	.23	12.0, 10.9, 11.4	11.4	.18	26.0	197	11.6, 12.2, 11.3	11.7	2.2
	L/2	.34	12.9, 12.1, 13.2	12.7	.16	29.0	229	13.3, 13.1, 13.5	13.3	2.2
	H/2	.39	13.1, 14.4, 13.9	13.8	.18	31.5	248	15.5, 16.0, 15.5	15.7	2.0
	S/2	.67	16.5, 16.0, 15.0	15.8	.22	36.1	235	19.7, 17.3, 17.8	18.3	2.0
3 Hours at 850°C – Cooled in Still Air [DN]	P/2	.02	–	11.5	.19	26.3	187	11.8, 11.6	11.7	2.2
	L/2	.19	–	13.0	.19	29.7	174	13.0, 13.9	13.5	2.2
	H/2	.35	–	13.1	.20	29.9	179	14.6, 14.1	14.4	2.1
	S/2	.60	–	14.3	.25	32.5	214	15.2, 15.4	15.3	2.1
3 Hours at 750°C – Furnace Cooled. [C]	P/2	.01	10.1, 10.3, 10.5	10.3	.17	23.4	207	10.5, 9.1, 8.1	9.2	2.5
	L/2	.01	12.0, 12.5, 12.8	12.4	.19	28.3	192	12.8, 11.7, 12.4	12.3	2.3
	H/2	.05	12.8, 12.2, 12.7	12.6	.22	28.7	179	13.0, 12.5, 13.1	12.9	2.2
	S/2	.20	11.4, 11.5, 11.1	11.3	.28	25.8	164	11.2, 11.1, 11.6	11.3	2.3
3 Hours 850°C + 3 Hours at 750°C Furnace Cooled [DC]	P/2	nil	–	10.9	.17	24.8	187	10.3, 10.2	10.2	2.4
	L/2	"	–	11.8	.19	26.9	179	12.5, 12.3	12.4	2.2
	H/2	"	–	11.8	.22	26.8	146	12.0, 11.9	11.9	2.3
	S/2	"	–	10.5	.28	23.9	121	10.0, 10.4	10.4	2.3

In Fig. 6 the maximum strength corresponded with a completely pearlitic matrix. Considering this in conjunction with the present experiments it seems conclusive that, with medium and low silicon irons at least, the greatest strength is obtained when the matrix contains neither free-cementite nor free-ferrite but is entirely pearlitic.

Taking the fully annealed metal in Table V as standard (Treatment D.C.), the maximum differences in strength are as follows:—

Grade.	Transverse test. Per cent.	Tensile test. Per cent.	Brinell test. Per cent.
P/2	5.5	14.7	22.4
L/2	10.2	12.1	34.6
H/2	25.4	37.0	74.0
S/2	50.5	76.0	99.2

These figures show that the changes which can be produced in metal in which combined carbon is stable are of no mean order. The Brinell hardness figures also show big variations, and there is no doubt that for any one grade the Brinell hardness gives some indication of the amount of combined carbon present.

The fact that the above remark must be restricted to one grade only is brought out by Fig. 8. In this the minimum Brinell hardness which was produced by a full annealing (Treatment D.C.) is plotted against the silicon content of the iron. It is true that the total carbon, which is higher in the S/2 metal than in others, is not taken into account. The results are therefore to some extent approximate.

The curve is somewhat startling, however. Thus the P/2 metal was not reduced below 187 Brinell, whereas the S/2 metal drops to the very low figure of 121. The hardening action of silicon is very apparent.

From a point of view of obtaining very soft irons for rapid machining the figures are of practical interest, also the curve has possibilities in the way of establishing Brinell limits for annealed castings of different grades. The curve given will not, of course, hold quantitatively for the output of all foundries, as naturally the figures will vary somewhat according to general composition, but it is easy to find the minimum hardness for any class of iron.

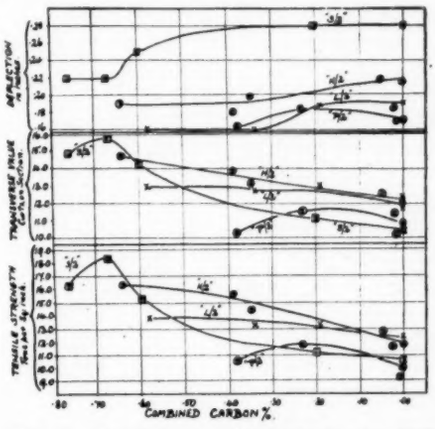

FIG. 7.—THE STRENGTH PROPERTIES VARY WITH COMBINED CARBON. PLOTTED FROM TABLE V.

Another interesting point brought out by Table V is the remarkable concordance between the transverse and tensile tests irrespective of composition. Table IX, which includes chilled irons, shows the same feature. This is in line with the findings of various workers, and confirms the relationship between the two tests which has been more or less generally accepted for a number of years. It is evident that tensile and transverse tests measure the same property. Of the two the transverse test is the more simple, and on machined bars slightly more consistent. Also it is possible to retain more fully the original size of the bar, which is an advantage.

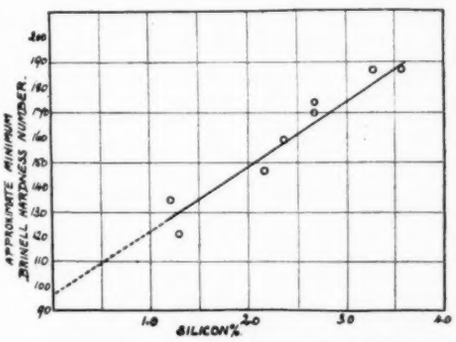

FIG. 8.—VARIATION OF MINIMUM BRINELL HARDNESS WITH SILICON CONTENT. FIGURES TAKEN FROM TABLE IX ARE ALSO PLOTTED ON THE CURVE.

The transverse values have been calculated to moduli of rupture by the usual formula.[8] The P/2 bars, given treatments "C" and "D.C" (Table V), show a rather high ratio between the modulus of rupture and the tensile strength. This is due probably to the fact that the pulley-bars, being high in silicon, were somewhat open in grain towards the centre; the tensile test being made on a 0.564-in. dia. bar would be more affected by this than the transverse test. In general, however, although tensile tests were made on both the 0.564- and 0.798-in. dia. bar no difference in result was obtained.

(To be continued.)

D

An Improved Form of Electric Resistance Furnace.*

By W. Rosenhain, D.Sc., F.R.S.,† and W. E. Prytherch, M.Sc.‡

Existing types of electric resistance furnaces, whether for laboratory or industrial use, suffer from certain limitations. Those which are heated by means of wire resistances are limited as to maximum temperature by the nature of the wire. The use of the high-melting metals, such as tungsten, molybdenum, etc., is rendered difficult by the necessity of heating them either in a neutral atmosphere or *in vacuo*. The platinum metals are excessively expensive except for quite small furnaces, while wire windings of nickel-chromium alloys can rarely be used for any length of time at temperatures exceeding 1,200 deg. C. On the other hand, furnaces working with carbon resistors either entail the use of heavy currents or, where granulated carbon or similar material is employed, suffer from the difficulty of securing and maintaining uniformity of heating throughout the resistor. In the carbon-resistance furnaces as hitherto constructed, moreover, combustion of the carbon has to be prevented by maintaining around it a neutral atmosphere, such as hydrogen or nitrogen, and in these circumstances the presence in the furnace of a strongly reducing carbon-bearing gas can scarcely be avoided. The type of furnace to be described below has been developed mainly for the purpose of furnishing, for laboratory purposes, an inexpensive type of electric resistance furnace capable of continued use at temperatures well above those obtained by means of ordinary wire-wound furnaces—*i.e.*, up to and above 1,400 deg. C. The absence of any serious combustion of a carbon resistor was also regarded as essential. The type evolved, however, has proved particularly adaptable, so that it is possible that it may find application on a much larger scale than that originally contemplated.

In the type of furnace in question a carbon resistance is employed. Following the lines of the "carbon-ring" furnace previously developed by one of the authors and E. A. Coad-Pryor,§ the carbon resistor has been cut up into slices or sections, and the heat in the furnace is generated not by the passage of a heavy current through uninterrupted carbon, but by the passage of a relatively small current through the contact surfaces between successive rods or pellets of carbon or graphite. The use of this device makes it possible to operate with much lower current densities than would otherwise be necessary to secure high temperatures. Further, the use of solid end-pieces of graphite or carbon provides the resistor with comparatively cool ends, to which electrical contact can be made without the necessity of introducing water-cooling. The most characteristic feature of the present type of furnace, however, is that the carbon resistor, consisting, for example, of short rods or pellets, is placed in a sheathing tube of a refractory material rendered as impervious to the passages of gases as possible. The carbon rods or pellets are made to fit only loosely into the refractory sheath or sleeve, since otherwise thermal expansion and contraction might lead to the fracture of the sheath. It is found, however, that, for example, with pellets having a diameter of 6.2 mm. a clearance of 0.4 mm. is sufficient to prevent risk of fracture from such a cause. At the same time it is found that diffusion of gas through the sheath is also very slight. The result is that the carbon or graphite pellets within the sheath, although heated to a very high temperature, such as 1,300 to 1,400 deg. C., do not suffer appreciable oxidation even when heated for many hours continuously. Carbon resistors of this type can therefore be used at high temperatures for long periods of time without appreciable change of resistance or deterioration of any kind. In one instance, a small furnace of this type was kept at a temperature ranging from 1,200 to 1,400 deg. C. for several days, and at the conclusion of this period the pellets from the heaters were removed and examined. They were found to have undergone no appreciable change of appearance or dimensions.

The principle of the sheathed carbon contact resistance may, obviously, be applied in a variety of ways and upon whatever scale is desired, provided that refractory sheathing tubes of the requisite size and strength can be obtained. It is, in fact, only the question of obtaining suitable tubes that sets a limit either to the temperature to which the furnace can be raised or the size in which it can be constructed. In one of the most satisfactory forms of this furnace, the principle has been applied to the heating of a small muffle measuring 11 cm. by 11 cm. in cross-section and 28 cm. in length. The muffle itself is made of a carborundum body, and holes in the sides of the muffle are provided for the passage of the heating elements. In the floor, recesses are provided to take the heating elements in such a manner as to leave a comparatively level floor for the muffle. A completely level floor can, of course, be secured by superposing a thin flooring slab of suitable refractory material. The furnace in question is heated by fourteen heater elements passed horizontally through the muffle, seven near the top and seven through the floor. These heater elements consist of refractory tubes 7 mm. internal dia. and 40 cm. in length, packed with pellets of ordinary arc carbon 15 mm. long, occupying a length of 10 cm. in the middle of each tube. The ends of the tubes are filled with solid rods of graphite which project at either end beyond the refractory sheathing tube. The detailed arrangement of the heating element is shown in Fig. 1 where R is the refractory tube, A1, 2, etc., are the carbon pellets, and E1 and E2 the graphite rods referred to above. At each end the graphite rod is held in a brass sheath, which is pushed against the graphite rod by means of a spiral spring at one end, pressing against a suitable abutment. In this way a constant pressure is maintained between the contact elements of the heater, thus securing constancy of electrical resistance in the element.

The resistance of the furnace can be so arranged by the choice of pellets of suitable length that, when a control resistance is used in series with it, any ordinary main supply voltage can be employed. In the particular furnace described a 140-volt supply was used. With a current of 30 amp. this is sufficient to raise the temperature of the furnace rapidly. Considerably less power than this (about 2 kw.) is sufficient to maintain the furnace at 1,200 deg. C.

The electrical resistance of the furnace decreases with increasing temperature, the decrease being about 50 per cent. between room temperature and 1,200 deg. C. This is an advantage, since a smaller control resistance is sufficient. At any given temperature, however, the resistance of the furnace remains unchanged, since no change in shape of the pellets has yet been found to occur, even after prolonged periods. The constancy of the resistance of the furnace is evident from the current consumption, which does not change appreciably during prolonged use. No actual measurements of change of resistance with time have, however, been carried out.

Electric Resistance Melting Furnances.

In another form, a furnace on the same principle has been constructed for the purpose of experimental steel melting in the laboratory. In this case, the resistor is of the type ordinarily used in the "carbon-ring" furnaces, but, instead of packing these rings on the outer side with finely divided carbon (soot) the rings are enclosed between two refractory sheathing tubes. Some difficulty has been experienced in obtaining tubes of the size required for this furnace, which is 10.5 in. in dia. and 27 in. in length internally. Some tubes which have been obtained from a British maker, however, have proved reasonably satisfactory even when the furnace has been kept for many hours at a temperature sufficiently high for steel-melting purposes. There is, however, a tendency for the outer tube to contract, and it is feared that this may ultimately damage the graphite rings. In this particular furnace, the refractory tubes employed could not be obtained of sufficiently accurate dimensions to give the desired close fit upon the graphite rings, nor is the impermeability of the refractory to gas as high as could be desired. In consequence, a certain amount of carbon monoxide gas makes its presence felt in the interior of the furnace. Nevertheless the graphite rings, after repeated use, show very little sign of attack.

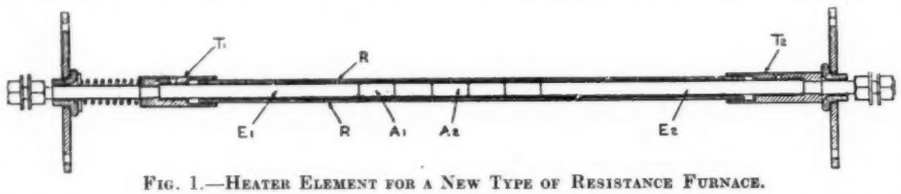

Fig. 1.—Heater Element for a New Type of Resistance Furnace.

It will be seen that both in this special type of ring furnace, and in the furnaces constructed with a number of separate heating elements, the real limitation to the range of applicability of the furnace resides in the refractory materials For small tube heater elements, sheathing tubes capable of withstanding temperatures between 1,300 and 1,400 deg. C. for prolonged periods are now obtainable. It is, however, probable that in the near future tubes capable of working at considerably higher temperatures may be produced. Even with the above-named limit of temperature, however, this type of furnace offers possibilities which cannot be obtained by the usual wire-wound type of resistance furnace, while it avoids many of the difficulties and disadvantages inherent in ordinary carbon-resistance appliances.

Acceptance of an order from Messrs. Bolckow, Vaughan & Company, Limited, Middlesbrough, for the supply of 2,000 tons of steel rails required by the Tramways Department is recommended by the Glasgow Corporation Tramways Sub-Committee on Works and Stores. The tender amounts to £19,700, and is the lowest made by a British firm. The offer of a Belgian firm for the contract amounted to £16,800, but the sub-committee recommends acceptance of the offer by the Middlesbrough firm on the ground that early delivery is promised.

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§ Rosenhain and Coad-Pryor, "A High-Temperature Electric Furnace," *Trans. Faraday Soc.*, 1918, 14, 264–270.

The Gas-Permeability of Moulding Sands.*

By F. Maske & E. Piwowarsky.

Most of the methods used for ascertaining the permeability of moulding sands to gases consist in forcing a definite quantity of air or other gas, working at a regular or an irregular pressure or suction, through a sample of loose or compressed sand and ascertaining the pressure required, the differences of pressure occurring, and the time required for a definite quantity of air to flow through. (Steinitzer, H. le Chatelier, Shaw, and others.)

All these methods, which give the degree of permeability of the moulding sand to gases, admit of a comparison with the conditions obtaining in practice. In all cases a definite quantity of air is inserted in the equation. Very little has previously been done, however, in the way of ascertaining the actual quantity of gas to be carried away by the sand under given conditions of service and enabling such quantity to be used for purposes of comparison.† All previous experiments simply show, then, which one of any given series of moulding sands tested is most permeable to gases.

The experiments described in this Paper were mainly directed to ascertaining the quantities of gas made during the operation of casting, and so obtaining direct data upon which to base the quality of the sand. It is possible, from the figures obtained, to derive a new method of determining gas-permeability better adapted to practical requirements, and to measure results which are definitely comparable.

The quantity of gas made on casting was ascertained indirectly by means of the following experimental arrangements:—

Arrangement I, Fig. 1, shows a drum T with a sheet metal ring B for taking the sand. B is fitted tightly against T. Connected up to the drum on one side is a rotameter (rotary gas meter), while a pressure gauge is connected to the small tube R projecting into the sand. On the other side of the drum is a compressed-air delivery pipe. This test is used for determining the permeability of sand mixtures to compressed air applied at a known pressure. The results are plotted in curve form, and are used as standards for the particular sand mixture tested.

Arrangement II, Fig. 2, shows a moulding box in the top part of which is the above-mentioned sheet metal ring B containing the sand to be tested. For measuring the temperature, a thermocouple is inserted in the sand and connected at the other end to a millivoltmeter. A sand mixture tested according to the first arrangement is now tested under casting conditions. The pressure of the gases at the back of the test core gives an indication of the volume of gases passing by reference to the values obtained from the compressed-air tests.

A test is made as follows:—The tube R, of $\frac{3}{8}$ in. diameter, is rammed into the sheet metal ring B ($4\frac{1}{2}$ in. dia. by $4\frac{7}{8}$ in. height), along with the sand to be tested. A small piece of wood H is placed underneath, and is used merely to give the desired distance *a* of this tube R from the top edge of the ring. When R has been firmly rammed in, H is removed and the space left filled up with moulding sand. A small pin of diameter corresponding to the internal diameter of the tube prevents the latter getting stopped up. The ring B, filled with sand, is inserted in the drum T, a compressed-air pipe connected with the drum through the cover D, the pressure gauge connected up to the tube R, and space II of the drum T connected up to the rotameter. If, now, air is admitted, it is compelled to penetrate the layer of sand. The rotameter indicates the quantity (volume) of air, and the pressure gauge the pressure.

The calculation of the gas-permeability from the experimental figures ascertained is based on theoretical considerations, and the permeability value given is obtained by dividing the gas volume by the pressure drop.

Having plotted the pressure and volume of the gas on a system of co-ordinate axes (Fig. 7), one can, as shown in test arrangement No. II, ram the sand-filled sheet metal ring into the top box above the pattern for the purpose of practical comparative tests.

The bottom box in these tests was made with a simple flat pattern $10\frac{1}{2}$ in. diameter and about $1\frac{1}{4}$ in. high. Before the casting was made the rammed tube was connected to a pressure gauge and the pressures occurring measured at equal intervals during the cooling of the casting. As there was a riser in addition to the ordinary gate, the air was able to flow out freely during the operation of casting. The gauge does not begin to indicate the pressure until the mould is actually filled.

The curve (Fig. 3) shows the results of a measurement of this kind. At the moment the mould and gate are filled with the metal the pressure-gauge suddenly jumps to maximum pressure, which then decreases very quickly and, later on, more slowly. From the initial shape of the curve, it might be assumed that the pressure could drop steadily and uniformly and the curve take a downward trend. But the pressure actually rises at an early stage (after about 2 minutes, in the example under discussion). The curve then again rises before slowly drooping down to the stage when the casting is perfectly cold.

The first deflection of the pressure gauge represents the pressure of the gases which form when the iron comes into contact with the mould. The gases are composed of products of distillation of the coal dust, the dissociation products of the water, water-vapour, and the gases liberated by the iron. A non-coal-dusted mould gave initially pressures as shown by the dotted curve in Fig. 3. The big difference in

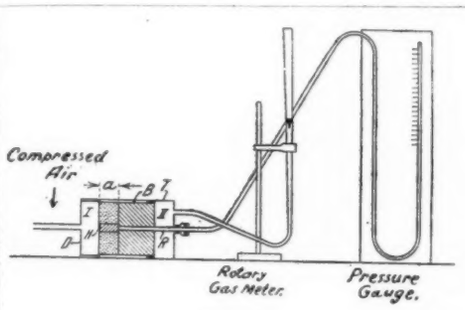

Fig. 1.

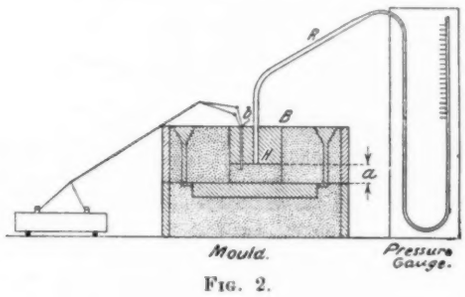

Fig. 2.

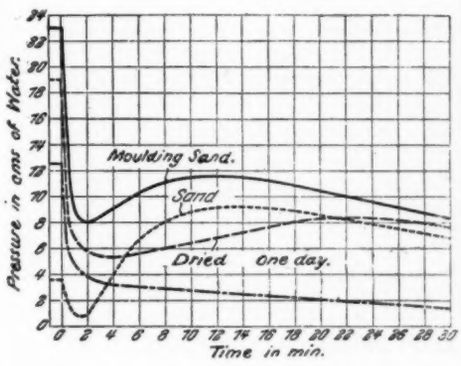

Fig. 3.

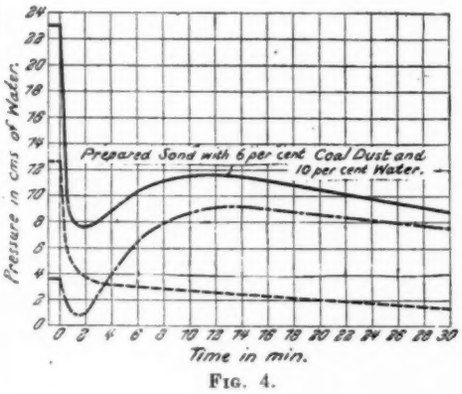

Fig. 4.

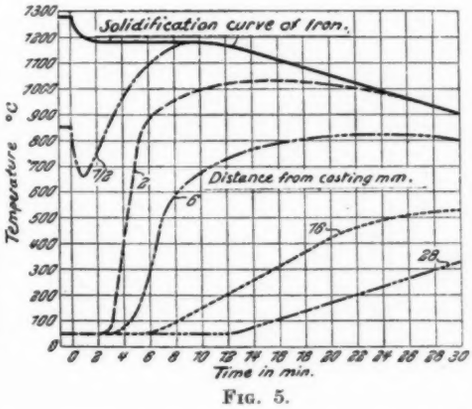

Fig. 5.

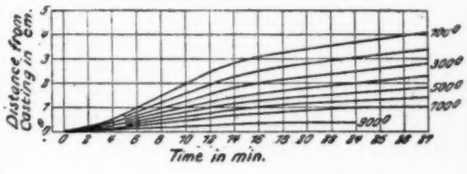

Fig. 6.

* Translated from "Die Giesserei," Vol. 24, pp. 559 *et seq.*

† cf. Dr. Fr. Roll, Giesserei-Zeitung, 1925, pp. 546–48.

the pressures measured, viz., 23 cm.* to 3.6 cm. is striking. Even here one can plainly see the effect of the coal dust on the volume of the gas or the pressure and permeability.

The first abrupt rise is possibly due to dissociation of the free water present in the moulding sand when it comes into contact with the liquid metal. The second jump is caused presumably by the water present in the moulding sand. The water in the sand that is farthest removed from the casting is evaporated in proportion to the heat given off to the sand. This steam finds its way to the periphery of the mould, condenses in the coldest layers, thus increasing the percentage of water in the latter. This causes an alteration in the gas-permeability of the sand. The extent of the effect of moisture on the pressure conditions in the mould is shown in Fig. 4, the moulds having taken one day and four days respectively to dry. In this curve the initial pressure of 12.6:19 is appreciably lower for the completely dried mould, while, in addition, the curve falls steadily. (Later tests have shown that the maximum gas-permeability must not be looked for in the dried mould.)

Measurements, made simultaneously, of the temperatures in several layers of the mould and in the middle of the casting gave the curves shown in Fig. 5. It will be seen that in the layers nearest the casting the temperature remains very low at the start, as the spontaneous liberation of steam, and probably dissociation as well, consume a great deal of heat, and the volume of gas which results prevents the heat being transmitted by conduction. Added to this are the gases given off by the iron. The first quantities of gas were passed over phosphorus pentoxide, and showed an absence of water—a sign that the water-vapour generated condenses in the mould. The increase of temperature in the layers removed from the casting rises to approximately the same extent that the gases generated decrease. This effect of the temperature causes the water present to evaporate at the same time. The curves of the several temperatures in Fig. 4 give information as to the progress of evaporation, especially the 100 deg. curve (Fig. 6).

In judging gas-permeability, the second rise in the curve is of no importance, because it is probable that only the volume of gas corresponding to the first rise of pressure has any bearing on permeability.

Plotting the pressure-gauge readings with test arrangement II (pressure only) in the curve obtained from test arrangement I (gas pressure and volume), one can read off the volume of gas producing an equal pressure. (It should be noted in this connection that the same sheet metal ring B with the same layer of sand and rammed-in tube was used in both experimental arrangements.) The pressure loss in the rotameter must of course also be taken into account. If, then, we take the maximum deflection of 23 cm. (Fig. 3) obtained during casting (test arrangement II) and reduce it to Fig. 7, we get a figure of 300 litres* of air per hour. This volume represents the volume of gas which would pass through the sand during a period of 1 hour while casting, and at constant pressure.

The gas which arises during the operation of casting has a different composition from air, so that the co-efficients of friction are different. Despite this fact, the figure of 300 litres of air found admits of comparison with the corresponding volume of gas. The pressure is affected by the composition of the gas. Consequently, in order to secure uniformity of composition, it is best to use compressed air for purposes of comparison in all the tests. From the gas analyses which were made during the tests it was found that the hydrogen content increases with increase in the percentage of water and coal dust.

It is possible by the tests made by this method to ascertain a comparative figure for the quantity of gas, without regard to the composition of the latter. By inserting in Fig. 7 figures found in actual practice (test arrangement II), the gas-permeability of the sand tested will be obtained. For instance, prepared sand, with additions of 10 per cent. of water and 6 per cent. coal dust will give a volume of gas of 300 litres per hour and a pressure of 23 cm. of water, and, comparably with these, a gas-permeability* of approximately 13. To ascertain the true volume of gas, however, a fresh analysis of the gas is necessary on each occasion. The comparative quantity of gas may, however, be pretty well predicted every time, when it is remembered that, in the normal course of events, the analyses do not fluctuate to any considerable extent.

The volume of gas is, however, markedly affected by the additions to the sand (coal-dust, moisture), by the size of the casting and the temperature of casting. In order to determine to what extent the volume depends upon these

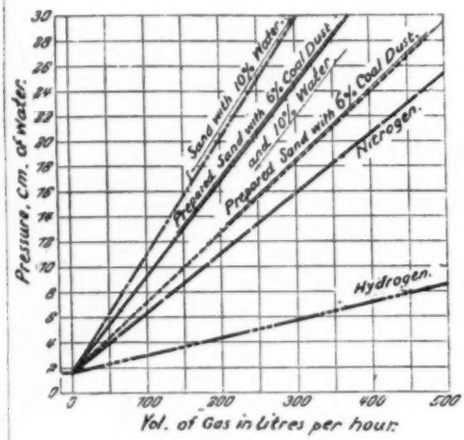
Pressure, cm. of water.
Sand with 10% Water.
Prepared Sand with 6% Coal Dust and 10% Water
Prepared Sand with 6% Coal Dust.
Nitrogen.
Hydrogen.
Vol. of Gas in Litres per hour.

Fig. 7.

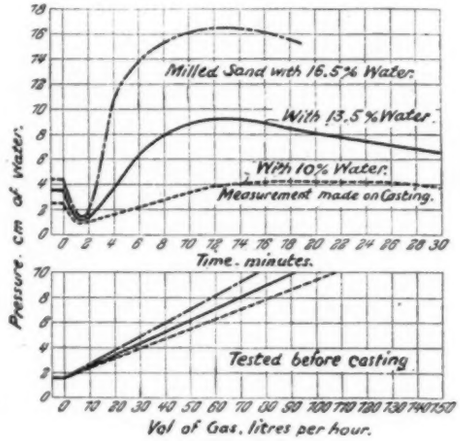

Fig. 8.

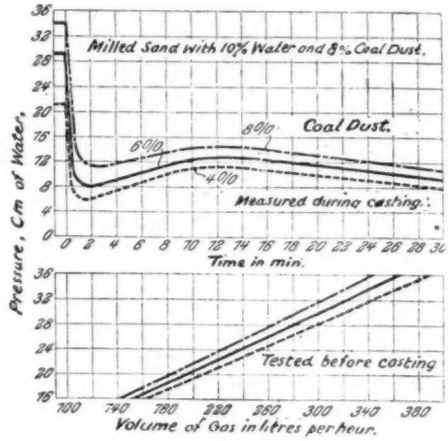

Fig. 9.

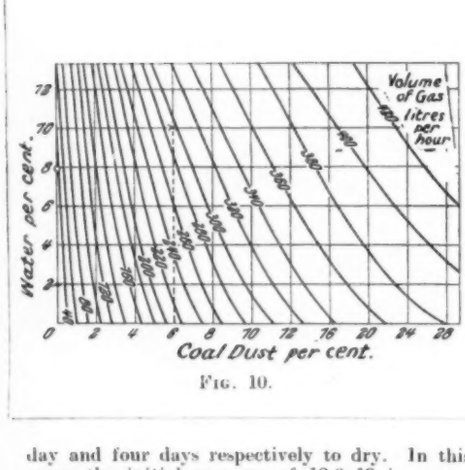

Fig. 10.

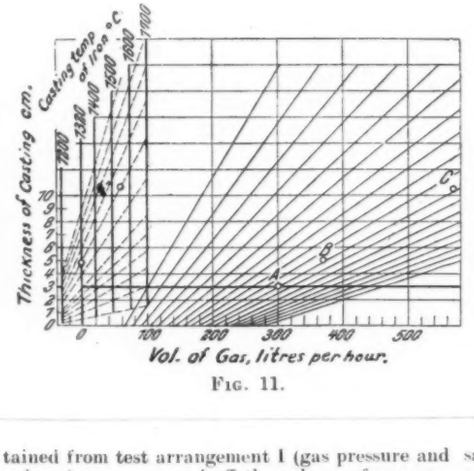

Fig. 11.

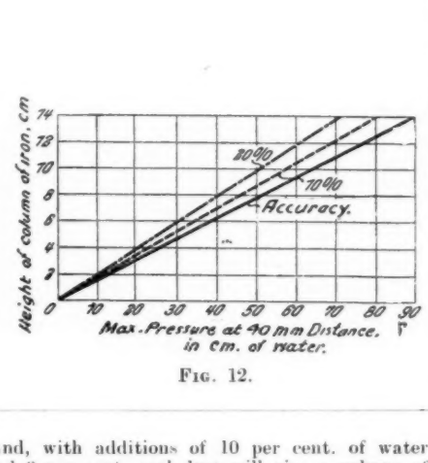

Fig. 12.

* 10 cm. are approximately equal to 4 in.

* 1 cubic foot is approximately 30 litres.

* Gas-permeability = $\frac{\text{Volume}}{\text{Pressure}}$.

factors, the experimental programme (Table I) was carried out:—

Table I.—*Experimental Programme.*

Constant Factors.	*Variable Factors.*
	I.
Edge-milled sand	Water, 10 per cent.
Temperature of the iron	,, 15 ,,
Casting	,, 16.5 ,,
	II.
25-mesh riddled sand	Water, 10 per cent.
Temperature of iron	,, 13.5 ,,
Casting	,, 18.0 ,,
Ramming	
	III.
8-mesh riddled sand	Water, 13.5 per cent.
Temperature of iron	,, 17.0 ,,
Casting	,, 21 ,,
Ramming	
	IV.
Water	Sand, edge-milled
Temperature of the iron	,, 25-mesh, riddled
Casting	,, 8-mesh, riddled
Ramming	
	V.
Water	Marl, 10 per cent.
Temperature of iron	,, 25 ,,
Casting	,, 50 ,,
Ramming	
Sand	
	VI.
Water	Marl, 10 per cent.
Temperature of iron	,, 0 ,,
Casting	Silica sand, 25 per cent.
Ramming	
Sand	
	VII.
Sand, edge-milled	Coal dust, 4 per cent.
Water	,, 6 ,,
Temperature	,, 8 ,,
Casting	
Ramming	
	VIII.
Prepared sand	Coal dust, 6 per cent.
Water	,, 10 ,,
Temperature	,, 14 ,,
Casting	
Ramming	
	IX.
Coal dust	Milled sand
Water	Prepared sand
Temperature	,, ,,
Casting	*plus* two-thirds floor sand
Ramming	
	X.
Dressed sand	Water, 10 per cent.
Coal dust	,, 14 ,,
Temperature of iron	
Casting	
Ramming	
	XI.
Dressed sand	Coal dust, 6 per cent.
Temperature of iron	,, 10 ,,
Casting	,, 12 ,,
Ramming	,, 14 ,,
	XII.
Sand	*Thickness of Casting.*
Coal dust	10½ in. × 0.2 in.
Water	10½ ,, × 0.6 ,,
Temperature of iron	10½ ,, × 1.25 ,,
Ramming	10½ ,, × 2.0 ,,
	XIII.
Sand	*Temperature of Iron.*
Coal dust	1,250° C.
Water	1,320° C.
Ramming	1,400° C.
	XIV.
Sand	*Ramming Strength according to Treuheit.*
Coal dust	0.5
Water	0.9
Casting	1.7
Temperature of iron	
	XV.
Sand	With coating of "blacking"
Coal dust	Without ,, ,,
Casting	
Temperature	
Ramming	
	XVI.
Sand	Dusted
Coal dust	
Casting	Not "dusted"
Water, temperature of iron, ramming	

Tests I, II and III.—The sand intended for these tests was completely dried, increasing percentages of water being then added to the dried sand. During its first rise, the pressure remained within narrow limits. The first marked rise of pressure was obviously appreciably affected by the distillation of the coal dust. Figs. 8 and 9 show the increase of pressure with increasing moisture. The volume of gas here remains the same. The gas-permeability is reduced by the high percentage of water.

The top part of Figs. 8 and 9 show the pressure readings obtained on casting when the test core is placed in a mould (Fig. 2). The bottom part of the figures show the curves obtained on the core in the apparatus shown in Fig. 1. The results are summarised in Table II.

Table II.

Type of sand.	Coal dust, per cent.	Water, per cent.	Pressure, cm.	Vol. of gas, litres/hour.	Comparative gas-permeability.
Crushed sand ..	—	10.0	2.7	34.0	12.6
	—	13.5	3.6	38.0	10.6
	—	16.5	4.4	40.5	9.2
25-mesh riddled sand	—	10.0	2.25	32.0	14.2
	—	13.5	3.0	37.0	12.3
	—	18.0	4.0	40.0	10.0
8-mesh riddled sand	—	13.0	2.0	32.0	16.0
	—	17.0	2.6	35.0	13.4
	—	21.0	3.2	37.0	11.6

Test IV.—The percentage of water being the same, the gas-permeability of the sand varies with the structure of the sand grains. It will be seen from Table III that the coarse-screened sand is much more porous than the fine-screened and crushed sand; for the pressure in the coarse-riddled sand is lower than in sands of finer grain with the same gas volume.

Table III.

Type of sand.	Coal dust, per cent.	Water, per cent.	Pressure, cm.	Vol. of gas, litre/hours	Comparative permeability to gases.
Milled sand	—	13.5	3.6	38	10.6
25-mesh riddled sand ..	—	13.5	3.0	37	12.3
8-mesh riddled sand ..	—	13.5	2.0	32	16.0

Tests V and VI.—In order further to elucidate the above-mentioned effects of size of grain on the gas-permeability, a set of separate tests was carried out. With increasing percentages of marl and the same percentage of water, the gas-permeability of the sand diminished. The gauge reading increased from 2 cm. with 0 per cent. of added marl to 2.8 cm. with 10 per cent. added marl, and 24 cm. with 50 per cent. of added marl. The permeability of the sand to gas rose when fine sand-blast silica sand was added to the test sand in the proportion of 1: 3.

Table IV.

Type of sand.	Coal dust, per cent.	Water, per cent.	Pressure, cm.	Gas volume, litres/hour.	Comparative gas-permeability.
1 mm. riddled sand.. ..	—	10	2.0	32	16.0
Plus 10 per cent. of marl	—	10	2.8	33	11.8
,, 25 ,, ,,	—	10	5.0	37	7.4
,, 50 ,, ,,	—	10	24.0	42	1.75
,, 10 ,, ,,	—	14	3.5	37	9.75
,, 0 ,, ,,	—	14	2.8	34	12.2
Plus 25 per cent. of silica	—	14	1.6	30	18.8

Test VII.—The coal dust added to the sand to prevent it caking has a profound effect on the quantity of gas formed, and, hence, on the pressure. By adding always the same quantity of water to the milled sand, and varying the percentage of coal dust, all the curves exhibit a higher pressure or a larger volume of gas with increase in the percentage of coal dust added. The rise of pressure is not caused only by a larger volume of gas, but by reduction of the gas-permeability due to the added coal dust. As Table V shows, in crushed sand the gas permeability with 10 per cent. of water and 0 per cent. coal-dust = 12, the volume of gas being 33.5 litres an hour and the pressure 2.8 cm. On adding 8 per cent. of coal dust the pressure was 34 cm. and the volume 340 litres an hour, the comparative gas-permeability being 10. The difference between 34 and 28.3 = 5.7 gives the increase of pressure attributable to the gas-permeability being reduced by the addition of coal dust.

Table V.

Type of sand.	Coal dust, per cent.	Water, per cent.	Pressure, cm.	Vol. of gas, litres/hour.	Comparative gas-permeability.
Milled sand	0	10	2.8	33.5	12.0
	4	10	21.1	240	11.4
	6	10	28.6	300	10.5
	8	10	34.0	340	10.0

Test VIII.—By using fresh sand for all the previous tests, subsequent tests could be more adapted to practical requirements. In actual practice it is usual, for reasons of economy, always to add old, used sand to the fresh sand, and to work it up in the proportion of 1: 2 with the average coal-dust content of 6 per cent. Tests with this prepared sand, and also tests made at the same time with a moulding sand containing 4 and 8 per cent. more coal dust, but with a uniform moisture of 10 per cent. gave the following figures (Table VI):—

Table VI.

Type of sand.	Coal dust, per cent.	Water, per cent.	Pressure, cm.	Vol. of gas, litres/hour.	Comparative gas-permeability.
Prepared sand ..	6	10	23.0	300	13.0
	10	10	30.1	360	12.0
	14	10	36.0	400	11.1

Test IX.—It will be seen that the gas permeability of treated sand is greater than where fresh sand is used.

Table VII.

Type of sand.	Coal dust, per cent.	Water, per cent.	Pressure, cm.	Vol. of gas, litres/hour.	Comparative gas-permeability.
Milled sand	6	10	28.6	300	10.5
Prepared sand	6	10	23.0	300	13.0

Test X.—Table VIII shows how different per-

centages of water affect the volumes of gas under otherwise equal conditions.

Table VIII.

Type of sand.	Coal dust, per cent.	Water, per cent.	Pressure, cm.	Vol. of gas, litres/hour.	Comparative gas-permeability.
Prepared sand ..	6	10.0	23	300	13.0
	6	14.5	34	330	9.7

Test XI.—When prepared sand is mixed with varying percentages of coal dust, say, 4, 6 and 8 per cent., and the mould dried, the result is an increase in the quantity of gas made during casting, and a slight diminution of the gas-permeability.

Table IX.

Type of sand.	Coal dust, per cent.	Water, per cent.	Pressure, cm.	Vol. of gas, litres/hour.	Comparative gas-permeability.
Prepared sand ..	6	0	12.6	220	17.5
	10	0	17.2	280	16.3
	12	0	19.6	310	15.8
	14	0	22.0	340	15.4

Test XII.—In the following tests, discs of 10½ in. diameter, and 0.2, 0.6, 1.25, and 2.0 in. thickness were moulded into the prepared sand as used at the works where the tests were made. Table X shows that the volume of gas made increases with increase in thickness of the casting (disc).

Table X.

Pattern.	Coal dust, per cent.	Water, per cent.	Pressure, cm.	Vol. of gas, litres/hour.	Relative gas-permeability.
10½ in. dia. × 0.2 in. ..	6	10	16.0	210	13.0
10½ „ × 0.6 „ ..	6	10	19.0	250	13.0
10½ „ × 1.25 „ ..	6	10	23.0	300	13.0
10½ „ × 2.0 „ ..	6	10	28.4	370	13.0

Test XIII.—The casting temperature also affects the volume of gas. At higher temperatures, a deeper layer of the mould is burnt.

Table XI.

Casting temperatures.	Coal dust, per cent.	Water, per cent.	Pressure, cm.	Vol. of gas, litres/hour.	Relative gas-permeability.
Pattern :—					
10½ in. dia. × 1.25 in.					
Temp. = 1,250 deg. C. ..	6	10	20.0	260	13.0
„ = 1,320 „ ..	6	10	23.0	300	13.0
„ = 1,400 „ ..	6	10	26.1	340	13.0
Pattern :—					
10½ in. dia. × 0.6 in.					
Temp. = 1,250 deg. C. ..	6	10	16.9	220	13.0
„ = 1,320 „ ..	6	10	18.8	245	13.0
„ = 1,400 „ ..	6	10	20.8	270	13.0

Test XIV.—Firmer ramming causes a reduction in the gas-permeability, and, hence, an increase in pressure. The hardness of the rammed mould was determined by the Treuheit ball impression method.

Table XII.

Ramming strength and mould hardness (Treuheit).	Coal dust, per cent.	Water, per cent.	Pressure, cm.	Vol. of gas, litres/hour.	Relative gas-permeability.
Firmly rammed : Ball imprint, 0.5	6	10	34.0	300	8.8
Normally rammed : Ball imprint, 0.9	6	10	23.0	300	13.0
Loosely rammed : Ball imprint, 1.7	6	10	14.3	300	21.0

Test XV.—The quantity of gas given off by a perfectly dried mould, and with 6 per cent. of added coal dust, produced a pressure reading of 12.6 cm. The same mould, however, coated with "blacking" (composition consisting of two-fifths graphite and three-fifths silex dressing stirred up with water and a binder), gave a reading of only 5.6 cm. This coating or composition, acting as a very fine layer, causes a less amount of gas to be given off. The gas-permeability does not decrease to any appreciable extent.

Table XIII.

Type of sand.	Coal dust, per cent.	Water, per cent.	Pressure, cm.	Vol. of gas, litres/hr.	Relative gas-permeability.
Treated sand	6	0	12.6	230	18.2
Treated sand, face "blacked"	6	0	5.6	98	17.5

Test XVI.—Sprinkling graphite into a wet mould of treated sand also prevents a large amount of gas evolving.

Table XIV.

Type of sand.	Coal dust, per cent.	Water, per cent.	Pressure, cm.	Gas volume, litres/hour.	Relative gas-permeability.
Pattern :—					
10½ in. dia. × 0.6 in thick					
Moulding sand without graphite	6	10	18.8	245	13.0
Ditto, with graphite ..	6	10	9.6	125	13.0
Pattern :—					
10½ in. dia. × 1.25 in. thick					
Moulding sand without graphite	6	10	23.0	300	13.0
Ditto, with graphite ..	6	10	13.8	179	13.0

The volume of gas resulting is, as all the tests show, primarily dependent on the thickness of the casting, the temperature of casting, the coal-dust and moisture contents of the mould, and the way in which the surface of the mould is treated. To ascertain the gas-permeability on a laboratory scale calls primarily for a carefully-prepared sample of sand. This is taken from the sand heap as an average good sample and carefully and thoroughly mixed for a long time. The sand is then carefully inserted in the test ring, which is provided with a tap. By rotating a rammer held by means of a friction bearing or by jolting at a definite height of lift and number of strokes, the sand is then carefully and evenly compressed. The surface is smoothed off, when the sheet metal ring can be inserted in the test apparatus.

Systematic tests gave the figures plotted in Figs. 10, 11 and 12, which cannot, however, be regarded as having a general application. If it be desired to ascertain the volume of gas in a given case, then all the factors in the curves which may have any influence can be considered. Here is an example :—With 6 per cent. of coal dust and 10 per cent. of water in the moulding sand, we obtain in a casting 1.2 in. thickness and cast at a temperature of 1,320 deg. C., a gas-volume of 300 litres an hour. Suppose, however, the pattern is 2 in. thick, the point of intersection of 30 mm. thickness and 300 litres per hour (A) is ascertained, and the curve passing through the point of intersection followed up to the point where the thickness = 50 mm. This point (B) indicates that the volume of gas is 370 litres per hour for the 50 mm. thick pattern. If, now, there should be a difference of temperature, say, 1,550 deg. C., instead of 1,320 deg. C., this will increase the volume of gas. Translating the point (B) to the vertical temperature line 1,320 deg. C., and following the dotted line passing through this point up to the temperature line 1,550 deg. C., we obtain on curve A-B the point of intersection C, corresponding to a gas volume of 570 litres/hour. With a pattern 50 mm. thick, the moulding sand with additions of 6 per cent. coal dust and 10 per cent. water, and a casting temperature of 1,550 deg. C., the volume of gas is 570 litres per hour (*i.e.*, if the first and maximum pressure in the mould were maintained for 1 hour, 570 litres per 100 sq. cm. of the mould would be given off during 1 hour).

The test arrangement shown in Fig. 1 (Arrangement 1) enables the gas-permeability to be determined, while Figs. 10 and 11 enable the volume of gas to be read off. It still remains to be ascertained how high the pressure can be in the sand in order to get a perfectly satisfactory casting. The pressure to which the sand is exposed by the volume of gas given off has been determined by the tests. By comparing this pressure with the ferrostatic pressure we can arrive at the height of the iron column, the gates and risers (Fig. 12). The two upper curves give the iron-heights with 10 and 20 per cent. accuracy respectively. All maximum pressures, which come below the curve, are lower than the ferrostatic pressure. If the pressure rises and overcomes the ferrostatic pressure, we get the phenomenon known in practice as "boiling iron." The major portion of the gases escapes through the iron. To prevent "boiling," the volume of gas must either be reduced, which, as we have seen, can be done by altering the composition of the mould, its treatment and surface property, or else the gas-permeability of the mould must be increased. It is possible in this way to provide data for judging definitely the suitability or otherwise of a sand.

Further particulars have now been filed regarding the English Steel Corporation, Limited, which was first registered last December, with a capital of £100. Complete details have already been announced in these columns with regard to the objects, which, briefly, are to acquire from Vickers, Limited, Vickers-Armstrongs, Limited, and Cammell Laird & Company, Limited, certain parts of their respective businesses and assets, but especially their steel businesses. The nominal capital of the new company is £8,000,000, and the prices to be paid by the company are :—In the case of Vickers, Limited, £500,921, payable by the allotment of £404,946 ordinary and £95,975 7 per cent. cumulative preference shares; in the case of Vickers-Armstrongs, Limited, £4,557,846, payable by the allotment of £3,272,031 ordinary and £1,285,815 preference shares; and in the case of Cammell Laird & Company, Limited, £2,632,688, payable by the allotment of £2,033,149 ordinary and £599,539 preference shares. The first directors are : Mr. T. L. Taylor, General Sir James F. Noel Birch, Commander C. W. Craven, R.N., Mr. W. L. Hichens, and Mr. R. Whitehead.

Foundry Trades' Equipment and Supplies Association.

The annual meeting of this Association, over which the chairman, Mr. H. Winterton, presided, was preceded by a luncheon, held at the Engineers' Club, Coventry Street, London. Amongst those present were Mr. H. B. Weekes, chairman of the Council of the B.C.I.R.A.; Mr. John Cameron, J.P., past president of the Institute of British Foundrymen; Mr. J. G. Pearce, B.Sc., director of the British Cast Iron Research Association; Mr. V. C. Faulkner, a past chairman of the Association; Mr. D. H. Wood (Constructional Engineering Company), Mr. D. W. Lennox (Britannia Foundry Company), Mr. H. G. Sommerfield (H. G. Sommerfield, Limited), Mr. Barrington Hooper (managing director, The Foundry Trade Journal), Mr. E. J. Penstone (Atlas Preservative Company), Mr. D. Sharpe (Foundry Plant and Equipment Company), Mr. Fearnley Allen (Fearnley Allen & Sons), Mr. F. J. Barraball (Blackfriars Foundry Equipment Company), Mr. G. T. Lunt (Bradley & Foster, Limited), Mr. A. C. Turner (General Refractories Company, Limited), Mr. G. C. Castle (Beecroft & Partners, Limited), Mr. Wilson (William Cumming & Company, Limited), Mr. Tichelli (Universal System of Machine Moulding), and Mr. K. W. Bridges, the honorary secretary.

In their replies to the toast of the guests, proposed by the President, both Mr. Weekes and Mr. Cameron acknowledged with gratitude the help given by the foundry equipment firms to the foundry industry by their ready co-operation in research and experimental work.

An interesting offer was made by Mr. Barrington Hooper, in the course of a short speech in which he outlined the present industrial and political conditions in Russia, to which country, as a member of the trade delegation, he is travelling in the course of a few days. Mr. Hooper offered to collect for members of the Association any information appertaining to the facilities for trading with that country and the prospect of business with its foundries.

After the notice convening the meeting and the minutes of the last annual general meeting had been read by the Secretary, the annual report was submitted, and is reprinted below.

Annual Report, Year Ending December 31, 1928.

The figures divulged by the audited accounts of the Association for the year under review, as attached hereto, are considered to be eminently satisfactory and to reflect a lively state of prosperity for an Association consisting necessarily of only a few members paying a nominal subscription. It will be observed that in comparison with the figures of the previous year, practically every item of expenditure is less, with the exception of that for Income Tax, which is inevitable. No items appear under the headings of Dinner Account, or Honorarium to Honorary Solicitors, and, of course, during the present year there has been no Handbook issued, and so the loss on the publication of that has not been repeated. It is very gratifying to note a substantial increase in the revenue from entrance fees and subscriptions, so that the balance of the trading account has been ameliorated, as has that at the Bank.

The chief activities of the Council during the year have necessarily been in connection with the Second Exhibition, to be held under the Association's auspices next June, and which is now known as "The International Foundry Trades' Exhibition, including Machine Tools and Woodworking Machinery." That Exhibition is still some six months ahead, but the preliminary detailed work must necessarily be undertaken early, and it is satisfactory to note that support for the undertaking is already promised from many interests which were unable to take part in the event of 1926. As is well known, this next Exhibition will have a peculiar significance owing to its relationship with the International Foundry Congress, which is to take place simultaneously with it, and which is not likely to recur in London under the official auspices of the International Foundry Committee for many years. The most assiduous endeavours have therefore been made to establish the closest liaison between this Association and those who are responsible for the Congress arrangements. The same applies in equal measure with regard to the Annual Convention of the Institute of British Foundrymen, which will also be held in conjunction with the Congress and the Exhibition, and delegates from this Association have been in closest touch with the Executives of the I.B.F.

One feature which emerges from these conferences, and which is considered to be of great interest to all members, is the agreement of a principle that the contributions of members of this Association towards the funds of the Convention, which have previously been made individually in response to appeals both from the Central Committee and local sections, are now to be paid into one Central Fund, to be raised by the Association. As a corollary to this, it is understood that branch secretaries of the I.B.F. and others will not make individual appeals to members of this Association, and that in the event of them receiving such appeals, unofficially or through inadvertence, it will be accepted as a complete answer that the matter is being dealt with through the Association's Central Fund.

In connection with the Exhibition, there are two other gratifying features which should be noted. The first is that negotiations have been completed with the Machinery (Machine Tool and Woodworking) Importers' Association of Great Britain, whereby a comprehensive exhibit of imported machine tools and woodworking machinery, etc., will be made in the Gilbey Hall, adjoining the main Exhibition building at the Royal Agricultural Hall. At the present time it is too early to speak definitely on the subject, but the Council has every confidence that a really creditable display of these specialities will be staged, and they feel that an additional interest will be attached to the whole Exhibition from this source, and the added number of buyers who will so be attracted will redound to the advantage of every exhibitor. The second feature is the very great enthusiasm which is being displayed in connection with the staging of the Technical Non-Commercial Exhibit, which, it is hoped, will show a marked advance on the similar effort in 1926. A stronger committee even than before has been formed once again under the able chairmanship of Mr. Wesley Lambert, and it is hoped that in this section, as well as amongst the commercial exhibits, a display will be made truly worthy of this country and calculated to focus the keenest attention of our visitors from overseas. Finally, it is hoped that the Association itself will be represented by an exhibit, and that by this means its ramifications may become more widely known both to the buyers of foundry equipment and supplies throughout the world, and to those engaged in those trades who are not already members.

Regarding the curve showing the average trend of business of those members supplying the data from which it was compiled, whilst the nature of the business of some of our members precluded their taking part, the Council proposes to continue the activity whilst any substantial interest is manifested.

The Council thought fit to procure a small badge of office to be worn by the retiring President, and it is hoped that the significance of this is appreciated by those privileged to behold it.

A suggestion was put forward during the year that some useful purpose might be served if a collection could be got together, at the offices, of the catalogues and publications of foreign undertakings carrying on similar business to that of members of this Association. Members were accordingly invited to forward copies of such publications to the Hon. Secretary from time to time, which would then be available for perusal at the office on application by any member. So far, no response has been made to this suggestion, but it is still open to members to supply such particulars at any time they may be in a position to do so.

At a council meeting which followed, Mr. Harry Winterton was re-elected president, and Messrs. D. H. Wood, D. Lennox, and A. S. Beech, vice-presidents. The meeting closed with an interesting statement by Mr. Bridges as to the progress achieved in the organisation of the forthcoming exhibition. Much more space has been disposed of than was the case three years ago. Mr. Bridges expressed his indebtedness to to the heads of the various Government departments, the national research associations and the modern universities for the work they were doing for the organisation of a composite technical exhibit. The Technical Advisory Committee was definitely and completely representative of every metallurgical research activity in Great Britain, and the industry was to be congratulated on the support accorded to it by these important bodies.

A Stanton Presentation.

A complimentary dinner to Mr. C. J. Ward, chief mechanical engineer to the Stanton Ironworks Company, who has resigned after 44 years' service, has recently been given at the works, when Mr. Ward was presented with a gold watch subscribed for by his colleagues.

Mr. Ward entered the service of the Company in 1885, and from 1893 until 1918 was blast furnace manager. Since then he has been chief chemical engineer.

Mr. C. R. Crompton (chairman of the Company), who also attended in company with Mr. E. J. Fox (managing director), referred to the value of Mr. Ward at Stanton, and spoke of the many improvements that had been carried out during Mr. Ward's period of office.

In acknowledging the gift, Mr. Ward said that when he began to manage the furnaces in 1893, Derbyshire iron was being sold in Staffordshire at 35s. a ton delivered, and best house coal at that time was 7s. 9d. at the pit. So far as the slag trade was concerned, it was then in its infancy. The first large order obtained was for the Great Northern Railway Company, when they were reconstructing their line between Lincoln and Skegness. One of the most important things that had occurred during the last 40 or 50 years was the reduction of the working shifts from 12 to eight hours, in which matter Stanton Coal and Iron Company was the pioneer in the Midlands. Another important event was the setting up of the Midland Iron Trade Conciliation Board, which regulated wages in the blast furnace and iron ore industry. The year 1900 was a particularly good one for the trade, pig-iron reaching 70s. a ton, but in 1901 it fell to 44s., and the companies had to ask for a reduction of wages. Representatives of the Bestwood, Butterley, Stanton and Denby companies, and of the principal trade union (of which Mr. Will Thorne was general secretary) met, and ultimately agreed on a scale of wages that would rise or fall with the price of pig-iron.

Mr. W. Woodhouse (chief chemist) and Mr. P. J. Fenwick also referred to the splendid service that Mr. Ward had rendered the coal and iron trade.

XUM

Recent Developments in Electric Furnaces.

By D. F. Campbell, M.A., A.R.S.M.

(*Continued from page* 196.)

Comparison of Costs.

In the case of the latter furnace a comparison was made between the furnace using electrical energy at 0.7d. per unit and a modern well-insulated gas-fired furnace utilising town gas costing 2s 9d. per 1,000 cub. ft., allowance being made for the difference in size of the two furnaces. The cost of operation may be divided as follows:—

(*a*) Heat required to warm the furnace from cold, which is an occasional expenditure. This utilised 35s. worth of electric energy against an estimated cost of 24s. 8d. for gas, showing a balance in favour of the gas furnace for this item.

(*b*) The constant cost of maintaining the heat losses. The cost of maintaining the electric furnace at temperature under working conditions was 30 units per hr., costing 1s. 9d., whereas the cost of gas to maintain temperature was 6s. 7d. per hr.

(*c*) The cost of heating up the metallic charge. The energy actually used to heat the charge is equal in both cases in quantity, but the cost of the calorie is cheaper in the case of gas.

On a year's operation the saving on item (*b*) in favour of the electric furnace is greater than the difference in favour of the gas furnace under the first and last headings, and thus electric heating is justified, both on account of cost and also an improved quality of product, due to accurate heat regulation.

Electrical heat-treatment is based on the change of electricity into heat, either by heat radiated from a resistor, provided with electrical current directly from the mains or by means of a transformer, or by resistance of the substance to be treated, as, for example, in the Snead process or the induction methods now being developed.

The methods of applying heat by external resistors depend upon the temperature desired, and, generally speaking, resistors of metallic alloys of the nickel-chrome series are the most advantageous for working temperatures up to 1,000 deg. C., while non-metallic resistors of carbon, carborundum, or silicon mixture must be used for high temperatures, until better heat-resisting resistance alloys are obtainable.

Metallic resistor furnaces form the greater number of those in use, and the design varies so much in heating methods and mechanical features that only a few typical examples can be described. The simplest form is, perhaps, the drying oven, which includes core-drying stoves and japanning ovens.

Low-temperature annealing of metals, such as aluminium and its alloys, at 500 to 600 deg. C., is an application which is justified where a close temperature control is required, and similar furnaces are used for tempering steel where very accurate heat-treatment is required.

Temperature control with gas-fired furnaces at low temperatures presents serious difficulties which are non-existent with electric heating.

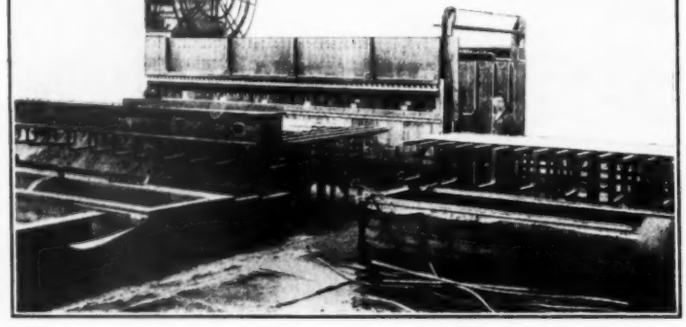

Fig. 6.

Medium temperature metallic resistor furnaces for the heat-treatment of steel, for carburising, hardening, pottery decorating, etc., are generally advantageous where electricity is reasonable in price and accurate control is required.

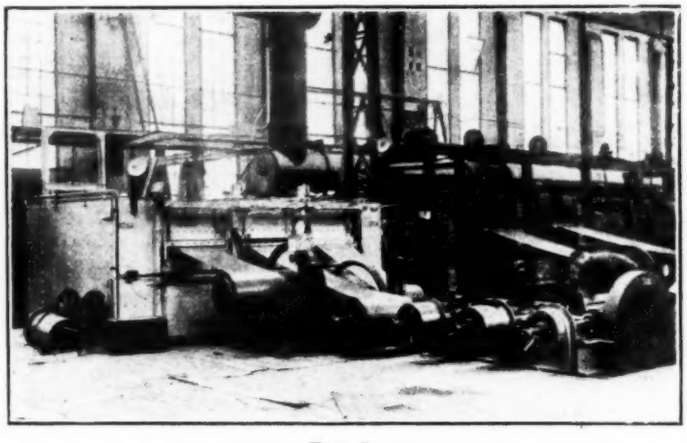

Fig. 7.

High temperatures in resistance furnaces are obtained by the use of graphite resistors covered with a ceramic glaze to prevent oxidation, and by the use of rods made of carborundum and silicon, and mixtures of these refractory electric furnace products. These are known under the trade names of "Silit" and "Globar," which are made in Germany and U.S.A. respectively. These bars give working temperatures up to 1,400 deg. C., but the design of highly efficient furnaces involves some difficulty owing to the leakage of heat through the bar itself and the electrical contacts. To reduce this, Silit rods are made to fit securely into a shorter rod of much larger cross-section than the resistance rod itself, thus reducing the heating effect in the exposed part of the bar. Round this a metallic wire is wound to connect to the bus-bar supplying current to the rod. Furnaces heated in this way are suitable for the heat-treatment of high-chromium steels, where rapid heating to high temperatures is required for softening stainless iron or steel strip.

Rating and Efficiency.

The rating of furnaces is a subject on which there is a good deal of misconception. The kilowatt input is not a measure of the value of equipment, and a 100-kw. inefficient furnace may well be less costly to build than efficient plant of 60-kw. rating. The manufacturer pays heavily for kilowatts where power is bought on a maximum demand basis, and in such cases he should demand from the furnace builder the smallest possible kilowatt rating that can produce the required amount of metal, as it is the product which should be the maximum possible with the rating reduced to the minimum compatible with efficiency. Thus a furnace of 60 kw. may be more costly to build, but more economical to run than a similar 100-kw. furnace.

In this connection the efficiency must also be most carefully considered, and the consumption of energy to maintain the required heat with doors closed, or the rate of temperature drop after the current is cut off, are simple and effective methods of specifying thermal efficiency. Without some such specification it is impossible to determine the relative merits of tenders for furnace equipment. Power consumption is always greatly increased if doors are frequently opened, and consequently the door mechanism should be efficiently designed and used as little as possible.

The price of electric furnaces, generally speaking, is high, and it may be of interest to explain how the cost is made up, and to indicate when high efficiency expensive furnaces are justified.

The cost of operating is almost entirely consumption of electrical energy, and this is utilised in heating the metal to the desired temperature, providing the latent heat of fusion when melting, and compensating furnace losses when operating. In addition, the time and energy required to bring furnaces to operating temperatures after Sundays and holidays, or in the morning when working day shift only, must be carefully determined in every furnace and for each schedule of work.

The proper design of doors and furnace structures is of vital importance to efficiency, but a large item of expenditure is good insulating material. Table I indicates the dissection of costs in (*a*) a simple box-type high-efficiency furnace; (*b*) a three-chamber annealing furnace

with recuperative features; (*c*) a 105-ft. two-track pottery-decorating kiln for highly efficient working on the contra-flow principle, with complete control and automatic regulation of temperature.

Table I.

	Furnace.		
	A.	B.	C.
Structural steelwork ..	28.8	24.3	4.5
Rails and bogies and mechanical pusher gear	Nil	15.1	20.8
Insulating and firebrick work	20.5	23.8	22.4
Electrical switches, transformers and instruments	25.6	5.7	7.5
Heat control instruments and pyrometers..	—	3.3	10.1
Nickel-chrome resistors ..	4.5	3.7	2.2
Nickel-chrome castings ..	6.0	2.2	1.6
Erection and sundries ..	14.6	21.9	25.2
Cables, &c.	—	—	5.7

From the above figures it will be seen that brickwork is a large item of cost, but this is justified by the low heat losses.

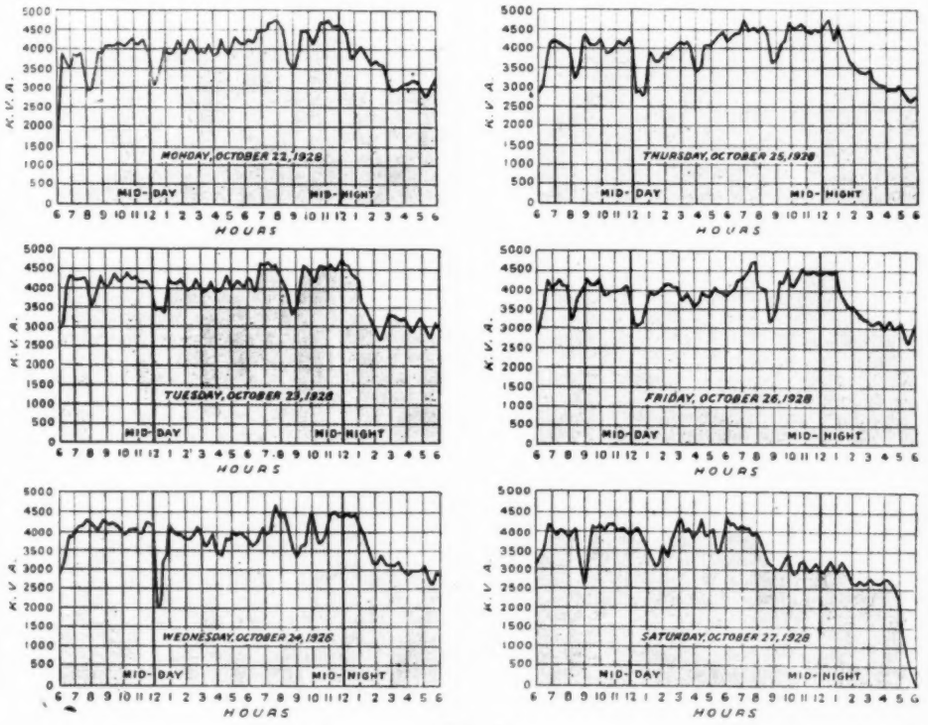

Fig. 8.

The following detailed description of several heat-treatment furnaces with definite figures of performance may be of interest. In the case of a simple box-type furnace (Fig. 6), having a hearth area of 4 ft. 3 in. by 3 ft. 3 in. and a height of 3 ft. 6 in., running at a normal working temperature of 517 deg. C., the radiation loss is 7 units per hr., while the same furnace, when working at 800 deg. C., has a radiation loss of 10.5 units per hr. This furnace will require 44 hrs. to cool from 700 deg. C. to 250 deg. C., or about 10 deg. C. per hr. These figures indicate the high efficiency of the insulation and design.

A simple form of heat-treatment furnace for coin blanks and small forgings and pressings is used in several works, having simple recuperative features. The loading of the furnace is 80 kw., and there is one heating chamber and two insulated hoods. The chamber in the furnace is 22 in. in diam. and 39 in. high. The power consumption per ton depends largely on the weight and type of boxes used, the reduction in one case being 17 per cent. when nickel-chrome sheet boxes were used in place of steel tubes. The power consumption for heating brass discs and forgings varied from 104 to 132 kw.-hr. per ton for slight variations in form and composition.

A side-charged tube annealing furnace, shown in Fig. 7, has the following characteristics. The power consumed when annealing brass tubes is 130 units per ton. The weight of each charge is 1 ton, and each operation is of 1 hr.'s duration. The rating of the furnace is 200 kw., and very special precautions in design and charging equipment are necessary, owing to the large door and consequent heat losses, unless charging and door mechanism are most carefully designed.

The Snead annealing machine gives a very efficient method of heat-treating rods or tubes, the time required for heating a tube being only 3 or 4 seconds, and the power consumption less than 50 units a ton. This machine consists of a bench about 25 ft. long, on which two clamps for holding the tubes are mounted. One clamp is fixed, and the other is on a carriage equipped with wheels on ball-bearings, each clamp being connected to one terminal of a transformer, which is controlled by a contactor switch operated either by hand or automatically.

To operate the machine, a girl first rolls a tube into position on the jaws and depresses a pedal. This causes two solenoids to close the clamps, the contactor switch is automatically closed, and the current passes through the tube, which expands as it heats, and pushes the carriage forward. The dial indicates the extent of this movement, and, when the desired expansion (and consequently temperature) is reached, an adjustable finger makes contact with the pointer, the contactor switch is tripped automatically, and the solenoids automatically release the tube, which is rolled down a slope to the bench below.

The continuous annealing of brass strip has made rapid progress during the last two years, and is advantageous owing to its general convenience and the improvement of product rather than to any direct saving in fuel consumption. This is a case where fuel costs alone do not favour electric annealing under normal British conditions, but the method is fully justified if all the advantages are taken into consideration.

The Continuous Annealing of Brass Strip.

The process cannot be described as bright annealing, as a simple pickling and drying process is required, but the quality of the strip is much improved, as the very fine film of oxide is quite even over the whole surface, which is not scratched as in the case of other continuous methods of annealing. This type of furnace can only be recommended at present for alloys containing less than 75 per cent. of copper, owing to excessive oxidation in the case of high-copper alloys or copper strip.

These furnaces, one of which is shown in Fig. 7, consist of three flat heating chambers each about 20 ft. in length and 3 ft. 3 in. in width, capable of annealing strip to a width of 34 in., or, alternatively, annealing three strips of lesser width at the same time. The strip hangs in the furnace in catenary form, and does not touch the floor, and consequently a very fine surface is obtainable. This appears to be the logical method of annealing strip, as continuous operation can be maintained with corresponding reduction of metal in process. Furthermore, the furnaces are so clean and heat losses so small that they can be put in a rolling-mill building without inconvenience. This method is limited in practice to strip varying from 0.3 mm. (0.012 in.) to 1.2 mm. (0.047 in.) in thickness, and furnaces of the three- or six-chamber regenerative bogie type would be recommended for annealing thicker metal in cases where electric heating is justified, while for thinner strip, equipment such as that used for aluminium foil would be applicable.

The continuous strip furnace is heated in the roof and bottom, and the metal emerges at 300 deg. C., a temperature at which no damage to quality occurs. The mechanism consists of unwinding drums, which can be rapidly replaced by ingenious mechanism, and the end of one strip is rapidly joined to the beginning of the next by an automatic riveting or welding machine, whereby the loss of time is reduced to a minimum.

As compared with annealing furnaces fired by gas, it has been found that electric heating gives a more even film of oxide, owing to the regularity of temperature. Consequently, light pickling requiring only a fraction of the time previously necessary, leaves a uniformly bright surface without the stains which occurred with gas-heating.

In the case of a furnace annealing 63:37 brass, the output of a chamber 3 ft. 3 in. wide is 5 tons per 24 hrs., when treating strip 0.5 mm. (0.019 in.) thick, and this output is increased substantially when annealing metal containing 67 per cent. of copper. The working temperature is 700 deg. C., and the power consumption varies from 155 to 200 units per ton. The rating of such a furnace is 60 to 100 kw., the latter power only being used when heating up the furnace after the week-end.

Electrification of Works.

The following description of the Aron Hirsch Works of the Hirsch Kupfer u. Messingwerke, A.G., near Eberswalde, Germany, the largest existing brass-melting shop and rolling-mills, may be of interest as showing the extent to which electricity is now being used in metallurgy of brass. The total energy used for electric melting and heat-treatment is 4,500 kw. The total power consumption is about 36 million kw.-hr. per annum at present, but when the present programme of electrifying the whole works is completed two years hence, the total power consumption is expected to reach 60 million kw.-hr. per annum. The annual increase

of load during the last three years and other technical information are shown in Table II.

Table II.

	1926.	1927.	1928.
Total load, kw.-hr. ..	16,699,960	25,966,000	32,552,170
Total day load, kw.-hr. ..	9,487,320	13,350,700	16,965,695
Total night load, kw.-hr.	7,212,640	12,615,300	15,586,475
Ratio—day to night load..	1.32 : 1	1.06 : 1	1.10 : 1
Reactive load, kw.-hr. ..	11,532,800	7,567,200	12,872,560
Ratio—reactive to effective load—tan ϕ	0.690	0.292	0.305
Corresponding cos ϕ ..	0.822	0.950	0.929
Maximum load, kw. ..	3716	5027	6010
Load factor	50.1	59.0	62.1
Highest monthly maximum demand, kw. ..	3,920	5,050	6,260
Lowest monthly maximum demand, kw. ..	3,010	3,630	5,010
Ratio—highest to lowest maximum demand ..	1.30 : 1	1.39 : 1	1.25 : 1
Motor load, kw.-hr. ..	—	13,060,689	14,721,488
Furnace load, kw.-hr. ..	—	12,905,311	17,830,682
Ratio—motor to furnace load	—	1.01 : 1	0.825 : 1

As a result of careful study and regulation of power and load factors, and a favourable power contract, the cost of power is about 0.3d. by day and 0.15d. by night, although the power is obtained from a fuel-burning station.

Melting Furnaces.

Melting furnaces consist of a large battery of Ajax-Wyatt furnaces of 120 and 60 kw. capacity, consuming about 190 kw.-hr. per ton melted in the case of the larger units, and 220 units per ton in the smaller furnaces when melting 60:40 brass. The total melting equipment installed, including spare furnaces, is 30 Ajax-Wyatt furnaces of 120 kw., and 5 furnaces of the same type of 60 kw., melting 250 tons per day. The melting capacity is now being increased to a still larger tonnage. Furnaces of this type are also used with special linings for melting nickel-brass, and more than 2,000 heats have been made in many such linings. In addition, a high-frequency Ajax-Northrup furnace is used for melting pure nickel and alloys containing high percentages of this metal. A special siliceous lining, fritted by the process already described to form a crucible in the furnaces, is used with excellent results, and alloys of a high degree of malleability and purity are being made. The power of this furnace is 100 kw., and it produces about 440 lbs. of nickel in 80 minutes.

Heat-treatment furnaces of several kinds are used, and 16 of various sizes are already in use or being constructed. One large three-chamber electric continuous strip annealing furnace about 20 ft. in length, and having a rated capacity varying from 60 to 100 kw., is used with success, and 2 similar gas-fired furnaces will shortly be converted to electric heating, and 4 more are being built. A great deal of work and expense has been necessary to perfect the equipment for this delicate operation.

Tubes are annealed in an electric furnace 26 ft. in length, which is charged from the side by a special charging machine. A feature of this furnace is the exceptionally well-designed and quick-acting door mechanism, which reduces the heavy heat losses which are inevitable with large side doors.

The normalising of tubes is done in a small Snead annealing machine, which has been previously described. The power of this is 100 kw., and the power consumption is 45 to 50 kw.-hrs. per ton, but it must be remembered that this equipment involves a heavy single-phase load of rather an intermittent character. It is, however, a highly efficient means of utilising power, owing to the extreme speed of generating heat and the speed of each operation (4 secs.), which reduces the time factor of the radiation loss to a minimum.

Other furnaces in these works are pot annealing furnaces, with chambers for heat recuperation. These are used for annealing small parts, such as coinage blanks. Each unit has a power of 80 kw., and the heating equipment is arranged in the form of a cylinder covered at the top, which can be put over the pot to be heated. Insulated hoods are provided for the heat exchange between the mass which has been heated and a cold charge, by means of which about 30 per cent. of the heat remaining in the annealed charge can be transferred and economised. Power consumption varies from 104 to 226 units per ton, according to the quality of the metal.

Electric billet-heating furnaces are also used, and it is the intention of the management to eliminate entirely the use of gas throughout the works in favour of electricity, for its convenience often justifies its use in cases where the actual gas fuel cost is less than that of the electrical units consumed.

Fig. 8 shows the power demand in these works, which employ electricity for more purposes than any other similar establishment. The heavy night load during the hours of cheap power and the excellent load factor indicates a very efficient organisation, and the power factor is maintained at a high level by suitable condenser equipment, though the heavy load of Ajax-Wyatt and resistance furnaces does much to counteract the low power factor of the rolling-mill motors. The power factor is corrected by a battery of oil-immersed paper and metal foil condensers to 0.95. The works just described have the largest production of any single metallurgical establishment producing brass, and the most general use of electricity.

In Great Britain there are many cases where the cost of power can be substantially reduced if proper steps be taken to improve the load and power factor, so as to get the best possible terms under a contract, but as the power contracts vary so much in different districts, it is advisable for manufacturers to consult men who have special experience in these intricate questions. For example, in one works, a contract is based on a fixed charge on the maximum demand measured over ½ hr. and charged on a 12-monthly basis. In addition, for every kilowatt-hour there is a fixed charge for the daylight hours, and a reduced charge during night hours, each being subject to a sliding scale dependent on the price of a certain quality of coal. In addition, bonuses and penalties are incurred for high or low power factors. This is a common form of contract, but it gives opportunities to experienced engineers to utilise their power to best advantage and obtain the cheapest rate.

It is hoped that this description of some recent applications of electricity to metallurgical operations, which have proved definitely advantageous to those who have had the foresight to utilise their capital in this way, will lead to an interesting discussion on the experiences of others and the requirements of metallurgists who are faced with difficult problems, for there is no doubt that the use of electricity in metallurgical practice is expanding with extraordinary rapidity.

Composition of Cutting Tools.

According to Mr. J. L. Gregg and Mr. C. W. Kuttner, of the Western Electric Company of Chicago, the composition of the recently-developed tungsten carbide cutting tools is:—

Name.	Form.	Carbon.	Tungsten.	Cobalt.	Iron
Thornan ..	Tool	3.94	95.05	None	—
Diamonite ..	Tool	3.91	95.65	None	—
Elmarid ..	Die	5.90	83.00	4.50	0.4
Widia ..	Die	5.68	87.40	6.10	—

Other alloys entering into this category have been called "Walramite" and "Carboloy."

The American output of malleable castings reached the record figure of 73,169 short tons in January. Orders on hand point to a continuation of this prosperity.

Perran Foundry.

DEVELOPMENTS OF THE CORNISH PUMPING ENGINE.

In the course of a recent lecture on "Perran Foundry and Its Productions," given by Mr. W. T. Hooper, of Falmouth, at a meeting of the Cornish Institute of Engineers recently, Mr. Maurice Gregory (President) in the chair, the lecturer said his object was to stimulate a greater interest in the study and preservation of records and information relating to Cornish engineers, engines and foundries. The Cornish pumping engine was still unsurpassed for mine drainage under such conditions as prevailed in the Duchy. Within 34 years of their departure from Cornwall the energy and ability of the Cornish engineers had raised the duty or efficiency of the engine from Watt's maximum about sixfold. This remarkable result was due to the labours of a famous school of engineers, all of whom were of Cornish descent or birth. The names of Hornblower, Trevithick, Vivian, Lean, Grose, Woolf, Sims, Hocking, Loam, Mitchell and Eustice were still household words. This great improvement in power and efficiency resulted in a great development of the mines, to such an extent that by 1838 nearly 300 engines were at work in the county, the majority being pumping engines. There was good reason to believe that most of these engines were made at Hayle or Perran Foundry, the latter supplying most of the machinery for the Gwennap mines and eastern district.

The lecturer traced the history of the foundry founded by Mr. Robert Were Fox, senior, Mr. John Williams and others in 1791, capable of supplying all the machinery required for the Gwennap mines, and dealt with its growth until the Gwennap mines ceased operations in 1879. Perran Foundry also figured in marine work, and about 1866 four or five steamers were engined for Captain Philip Thomas, of Falmouth. Mr. Hooper suggested that the Cornish Institute of Engineers might consider the permanent marking of the site of such engines as Newcomen's first and second engine, Smeaton's engine at Wheal Busy, James Watt's first, second and third engine, the Wheal Towan engine, the Frances shaft of the United Mines, which was sunk 200 fathoms in nine months, the site of Hornblower's compound engine, Taylor's engine, etc. Taylor's engine, which was built by the Perran Foundry Company in 1840 for the United Mines, was designed by Messrs. Hocking and Loam, the eminent Cornish mining engineers. The fame of this engine was due to its having performed the highest duty, over a long period, of any engine ever erected in the county. The Perran foundry enjoyed a world-wide reputation for its production of mining machinery, and to it the Royal Polytechnic Society owed its inception.

Applications for Trade Marks.

The following applications to register trade marks are extracted from the "Trade Marks Journal":—

"Medris," "Standynis," and "Stantranis."—Metals. Geo. L. Scott & Company, Limited, Morris House, Rochester Row, London, S.W.1.

"Carboloy."—Machine tools. The British Thomson-Houston Company, Limited, Crown House, Aldwych, London, W.C.2.

Device incorporating the Letters "S" and "D."—Iron and steel sheets. South Durham Steel and Iron Company, Limited, West Hartlepool.

The tender of Messrs. Edmund Nuttall, Sons & Company, Limited, of Manchester, of £670,390 for the construction of full-sized entrance tunnels on the Liverpool side of the Mersey has been accepted by the Mersey Tunnel Committee.

British Insulated Cables, Limited, who in 1925 issued a share bonus of 33⅓ per cent., are now making a bonus issue of one ordinary share for every four, together with three 5½ per cent. "A" preference shares for every eight ordinary.

STANTON
PIG
IRON
THE STANTON
IRONWORKS
COMPANY LIMITED
NEAR
NOTTINGHAM

Trade Talk.

Another furnace is to be put into commission at the works of the Sheepbridge Coal and Iron Company, Limited.

Messrs. William Doxford & Sons, Limited, Sunderland, have booked an order for a cargo vessel for London owners.

An order for a collier steamer has been placed with Messrs. Smiths Dock Company, Limited, South Bank, by North-East Coast owners.

The staff and friends of Messrs. Smith & Wellstood, Limited, Bonnybridge, held their annual social reunion in Bonnybridge recently.

An order for a Ruths steam storage plant has been placed by the Gas Light & Coke Company, London, for their works at Brentford.

The London and North-Eastern Railway have placed a contract with the Sentinel Waggon Works, Limited, for 18 Sentinel shunting locomotives.

Qualcast, Limited, held their annual dinner on March 23. Presentations of watches were made to six members who had been with the firm for over 20 years.

A fire occurred early in the morning of March 19 in the pattern-shop of Messrs. Mechans, Limited, Scotstoun Iron Works, Glasgow. The damage is estimated at about £2,000.

The General Refractories Company, Limited, announce that their telegraphic addresses are now "Genefrax, Sheffield," "Genefrax, Glasgow," and "Genefrax, Cannon, London."

The conclusion is reported from Bukarest of a cartel of all the Rumanian iron and steel industries, including the Reshitra Works and the Klausenburg Steel Company. The cartel will join the Continental Steel Cartel.

The Great Western Railway Company have placed an order with Messrs. Alexander Stephen & Sons, Limited, Glasgow, for the construction of a new steamer of about 290 ft. in length and propelled by single-reduction geared turbines.

A Select Committee of the House of Lords began consideration last week of the West Highlands Water Power Bill, which promotes a £2,730,000 scheme of electricity supply by utilising lochs and rivers in North-West Inverness-shire.

The annual report of Messrs. Burmeister & Wain, the Copenhagen engineering and shipbuilding firm, records a considerable increase in the demand for marine Diesel engines. During the past year the company delivered marine Diesel motors aggregating 148,148 i.h.p., and land plants totalling 4,375 i.h.p.

A feature of the Brooklands Automobile Racing Club's Easter programme is a race in which the competing cars will be run entirely on motor spirit derived from coal by low-temperature carbonisation. A trophy has been offered by Lt.-Col. W. A. Bristow.

Messrs. William Baird & Company, Limited, have restarted a number of the blast furnaces at their Gartsherrie Works, Coatbridge, which have been out of commission for a considerable time. Work is also being resumed at the firm's Bedlay coke ovens.

The members of the Ship Constructors and Ship Wrights' Association are taking a ballot for the election of a general secretary. Mr. William Westwood, J.P., Glasgow, technical adviser to the Association, who has been nominated by 58 branches, is one of the candidates.

The rise in the price of copper adds interest to the development which is taking place in County Wicklow, where copper-ore of low grade is in abundant supply. The mines were discontinued some years ago, but preliminary work is now being undertaken with a view to a resumption of mining operations.

A meeting of the European Zinc Cartel was held recently in Brussels to discuss the measures to be taken in regard to output for the second quarter of the present year. It was agreed to reduce the curtailments in the rate of production. In view of the improving situation, the price limit was lowered to £26 5s.

It was stated at the 68th annual dance of the Royal Metal Trades' Pension and Benevolent Society, held recently in London, that since the Society was founded in 1843, 2,310 persons had received help at a cost of £290,000. At present there were 270 pensioners, whose support demanded a weekly income of £140.

The Department of Overseas Trade has announced that the British Industries Fair will be held next year at Olympia instead of at the White City, where it has been held for the past few years. The fair will, as usual, open on the third Monday in February—namely, February 17—and will remain open until Friday, February 28.

The annual statement of the United States Steel Corporation for 1928 shows net earnings of $126,068,000, compared with $105,418,000 for the previous year. The surplus net income for the year is $39,140,000, compared with $12,864,000 for 1927. Gross receipts were $1,374,443,000 ($1,310,393,000), and total earnings $200,986,000 ($172,315,000).

Workmen at the Hallside works of the Steel Company of Scotland, Limited, have, at the request of the employers, extended their working day from eight to ten hours, time-and-a-half rates being paid in respect of the additional hours. In view of the firm's observance of overtime conditions, no objection to the arrangement has been made by the Iron and Steel Trades Confederation.

Among contracts which have been secured by the Motherwell Bridge and Engineering Company, Limited, is one for a number of oil-storage tanks, each capable of holding 2,500,000 gallons, which are to be shipped to Persia, to the requirements of the Anglo-Persian Oil Company. About 14,000 tons of steel will be needed for the fabrication of the tanks, orders for which, it is stated, are being placed in the Motherwell district.

A pleasing little function took place in the Carron Ironworks last week. The occasion was the honouring of Mr. Malcolm Roughead, who was severing his connection with "Carron" after eighteen years' service. He is leaving to take up an important appointment with Messrs. Lane & Girvan, Bonnybridge. He was presented by his fellow-workmen and a few friends with a gold watch as a parting gift.

Obituary.

Mr. F. S. Wilkinson, a director of Messrs. F. Grazebrook & Company, Limited, iron and steel merchants, Dudley, died on March 15.

Mr. J. W. Jenkinson, analytical chemist at the works of the Shelton Iron, Steel and Coal Company, Limited, Stoke-on-Trent, died recently in his 37th year.

Mr. George Dunstan, mill manager at Messrs. Brown Bayley's Steel Works, Limited, Sheffield, died recently at the age of 70 years. He had completed 52 years' service with the firm.

Resulting from an accident on March 6, the death has occurred of Mr. T. J. Simpson, who was a member of the Liverpool staff of the Falkirk Iron Company, and had been in the firm's employ for over 55 years.

The death has occurred of Mr. Harry Fitzmaurice Huntsman, at Lound Hall, Retford. He was a descendant of Mr. Benjamin Huntsman, the inventor of crucible cast steel, and was one of the best-known men in the steel and coal trades.

Mr. George Morrison Hay, managing director of Messrs. G. M. Hay & Company, Limited, Strathclyde Foundry, Bridgeton, Glasgow, died at his residence in Rutherglen, on March 19, at the age of 77. Mr. Hay, who was a native of Tillicoultry, took a leading part in the affairs of the West of Scotland Ironfounders' Association, of which he was chairman for a number of years, including the war period.

Personal.

Mr. Allan B. Field, consulting engineer, of Manchester, is one of four recipients of the John Scott medal at Philadelphia for outstanding scientific work.

Mr. Charles N. Pickworth, Wh. Sch., who for 40 years has been editor of the "Mechanical World" and associated publications, has retired from that position. Mr. Pickworth, who is the author of several technical works, will continue his consulting practice. His new address is 17, Griffiths Drive, Southport.

Mr. Andrew Crawford, J.P., chairman and managing director of the Bestwood Coal & Iron Company, Limited, is retiring, owing to his advanced age, at the end of March, and will be succeeded by Captain Claude G. Lancaster. Mr. Crawford is retiring at the same time from the boards of Lloyds Ironstone Company, Limited, and the North Lincolnshire Iron Company, Limited, and from the positions he has held with Messrs. Stewarts & Lloyds, Limited, at their various blast-furnace plants.

Will.

Sheldon, J. G., a director of the Darlington Forge, Limited, and interested in Cowans, Sheldon & Company, Limited	£37,822

Students' Corner

Q.—How would one describe black-floor sand?

A.—Black sand for adding to facing mixtures is usually taken from the moulding floor. It is sand that is partly spent, and has been used over and over again for ramming purposes behind the facing sand. It accumulates on the foundry floor due to fresh facings coming daily into use.

Q.—Are the same mixtures of sand suitable for both moulds and cores?

A.—In many cases they are, but usually core sand should contain more opening material than facings for moulds the reason being that cores are more often surrounded with metal when in the moulds, hence the sand mixtures for cores should be more porous to allow the expanded air and gases to escape easily and quickly into the larger vent passage provided.

Q.—Can mixtures for core sands, and mixtures for loam work with the necessary processes be given similarly to facing sand mixtures?

A.—To some extent that may be done, but it must be remembered that material and treatment varies according to the class of work envisaged and the general practice in various foundries, but for a general jobbing foundry which deals with medium and heavy castings the following may be given, but, of course, it is only approximate.

Small plain cores for light work only:—New sand, 1 part; old sand, 3 parts together with a thin sprinkling of dry bonding powder, or gum; the whole to be passed through a rotary mixer.

Core sand mixture for fairly large cores:—New sand, 2 parts; Partly spent core sand, 2 parts, and opening material, 1 part. The mixture to be milled in a roller mill for 10 minutes.

Ordinary Loam Mixture:—New sand, 3 parts; Old sand, 3 parts; Opening material, 1 part, together with a small addition of cow hair. The mixture to be milled for 15 minutes.

Special Strong Clay Loam:—New sand, 3 parts; Clay, 2 parts, and Chopped straw, 1 part. The mixture to be milled 20 to 30 minutes.

Mixture for filling in Brickwork (brickwork backing):—New sand, 1 part; Old sand, 3 parts, and Chopped straw, 1 part. The mixture to be milled for 10 to 15 minutes.

Q.—For what purpose is special strong clay mixture used?

A.—Usually this strong clay mixture is used upon iron core barrels where two or three laps of straw, or hay ropes, have to be wound around the barrel to bring the required diameter up to size. It is often a wise proceeding if only one lap of thick straw or hay rope is employed to use on and between the bands a strong clay mixture when "roughing."

In all cases, this clay loam is only used in the roughing. After this is dried, the ordinary loam mixture is used for striking up to size. Where more than an inch and half of "stuff" is wanted to bring up to size on circular bars, or barrels, a much sounder core is made by using clay loam as a "bottom," on and between the ropes, especially is this the case if the cores stand vertically in the moulds when poured. The clay loam bottom around the straw bands will resist the pressure of the molten metal when being poured, and those swellings, and rope marks in the bore of the cylinder, or whatever the casting may be, will entirely disappear.

TRADE MARK.

"SERVICE BCM/GX FIRST"

SHEFFIELD STANDARD GANISTER

If a Cupola man shall pause from his lining,
And, full of despair, raise his voice in repining,
You will say to him, "Bill!
Now what is your will?
Say, what is your woe and why are you whining?"

If William's the man that I have in my mind
He will say to you, "Boss, tha' wert never unkind,
But tha's buying us stuff
Not sticky enough,
Not plastic and tough, never likely to bind.

"This rubbish is Ganister—only i'name
It's not the 'Best Sheffield,' so well known to fame.
It's price cutting muck
That gets us no luck
But brings half the troubles for which we get blame.

"The lowest price stuff's never cheapest i't'end
Watch the quality, too, when tha's money to spend.
Our coke is the best
And we buy it on test,
But for lining t'owd Cupola—why it's owt that they send!"

"Why, Bill," you will answer, "I'm sorry, my lad,
I know it's hard work when the Ganister is bad.
You shall have your own way
Now what do you say?
What's the very best Ganister you've ever had?"

"Why, Sheffield Standard Ganister is t'only kind to buy"
Bill said and wiped a tear of joy from out his bright blue eye.
"I used it in my youth
And I tell thi' Sir, the truth
Tha'll never want to change again nor think as t'price is high."

QUALITY IN GANISTER

Much harm has been done to the Ganister Industry by the indiscriminate sale of low grade mixtures as "Best Ganister."

The results of their use have given vendors of high priced Ganister substitutes an opportunity that would never have occurred if all makers of Ground Ganister had maintained a fair price for a high quality material likely to give the best possible service to the user.

Such a grade is now being made in large quantities and of guaranteed high quality, hand selected, raw materials under the description—

"STANDARD SHEFFIELD GANISTER"

by the

GENERAL REFRACTORIES Co., Ltd.

SHEFFIELD.

London. **Glasgow.**

'Phone :—
Sheffield 22311.

Telegrams :—
"Genefrax, Sheffield."

Iron and Steel Markets.

Pig-Iron.

MIDDLESBROUGH.—With the near approach of Eastertide, business in the Cleveland iron markets is generally expected to take a quieter turn, but, on this occasion, so far, there has been little slackening of demand for forward deliveries extending mostly to the mid-year period. This movement has had the effect of modifying the policy of the Cleveland Ironmasters' Association with regard to prices, and in the circumstances they have arrived at a decision which may be described as a measure of self-protection. They are still prepared to sell up to the end of June at current prices, but if consumers wish to place contracts beyond that date, they will be required to pay 1s. 6d. per ton more than the prices now ruling. Whether this will check the forward-buying movement remains to be seen. On the export side also business is on an improving scale, the tonnage shipped from Tees ports up to the 19th inst. having nearly doubled as compared with last month's corresponding aggregate. Subject to the proviso previously noted, Cleveland iron prices, both to home and foreign buyers, are unchanged as follow:—No. 1 foundry iron, 69s. 6d. per ton; No. 3 G.M.B., 67s.; No. 4 foundry, 66s.; No. 4 forge, 65s. 6d. per ton.

Pressure of demand for East Coast hematite continues unabated, and now also extends to foreign markets, Italy having recently been a heavy buyer, and already some 101,000 tons of this quality of iron have been exported to Mediterranean ports. Prices are still a matter for negotiation, with 73s. 6d. as a middle figure for mixed numbers and 74s. for No. 1 quality. On the North-West Coast, Bessemer mixed numbers are quoted 74s. per ton at works.

LANCASHIRE.—It is satisfactory to record that the recent drastic alteration as regards f.o.r. prices has had no unsettling effect upon business in local markets for foundry pig, and, although conditions generally remain quiet, delivery specifications against existing contracts are being received at the blast furnaces fairly regularly. For delivery in the Manchester district, Derbyshire makers are quoting 71s. per ton; Staffordshire 2s. 6d. per ton higher than this, and Scottish at about 90s. per ton.

THE MIDLANDS.—Current demand for foundry pig in the South Staffordshire area also has an improving tendency of late, and quotations are firm, as follow:—Derbyshire No. 3, 72s. 6d.; North Staffordshire No. 3, 75s.; and Northants No. 3, 69s., delivered local stations. No. 3 Scotch foundry pig-iron is firmer at from 91s. 6d. to 93s. 6d., also delivered locally.

SCOTLAND.—Although business in the Scottish markets for foundry pig is even quieter than usual, it is reported that preparations are being made to relight some of the local furnaces at present idle. It is understood, however, that this movement is not prompted by any better demand for pig-iron, but is necessitated by the makers having reduced their existing stocks to such a low point that it is imperative to replenish these in order to retain their customers. Prices are unchanged on the basis of 72s. 6d. for No. 3 foundry, f.o.t. furnaces.

Finished Iron.

At Birmingham this week there have been no further changes in the prices of the various grades of iron bars. Crown bars have a tendency in the upward direction, but the demand, although improving, has not reached big proportions, and any further increases in price might stifle the trade. Present quotations vary from £9 5s. to £9 15s., with bolt iron at £8 15s. to £9. There is no improvement in the demand for bolt iron, and what business is being placed, apart from a few odd lots, is going to Belgian works, whose prices are 30s. to 35s. a ton lower than those quoted by home makers. Staffordshire marked bars are quoted at £12 at makers' works, which, although not busy, are fairly well occupied at present.

Steel.

At Sheffield the steel market is firm and moderately active. There is a strong demand for basic billets, but very little movement in acid qualities. There is not much moving in crucible steels, but business in the high-quality steels in which Sheffield specialises is better. There is plenty of business about in motor steels. A weak feature is railway steel requirements. Current prices: Basic billets, soft, £6 17s. 6d. to £7; semi-hard, £7 5s.; medium, £7 15s.; hard, £8 15s.; Siemens acid, £8 15s. to £9; steel hoops, £9 5s. to £9 10s. Wire rods: Soft basic, £7 15s. to £7 17s. 6d.; medium hard, £9 2s. 6d.; hard, £10 5s.; acid, £12. In the tinplate market business continues quietly steady, with makers' quotations for coke finish ranging around 18s. to 18s. 3d., net cash, f.o.b. Welsh ports.

Scrap.

Markets for foundry scrap material generally have been in active demand, owing to holiday influences, and on Tees-side the moderate needs of the foundries have been met, with regard to ordinary heavy cast iron, at 62s. 6d., with machinery quality firm at 66s. In the Midlands there is a very much better demand for heavy machinery cast-iron scrap than has been the case for some time past, and 70s. delivered can be realised without difficulty. For light cast-iron scrap 55s. delivered is offered. In Scotland cast-iron machinery scrap is still scarce at 72s. 6d. to 75s.; heavy ordinary cast-iron scrap is quoted 66s. 3d. to 67s. 6d., and old cast-iron railway chairs at 70s., with light cast-iron scrap at 65s. to 66s. The above prices are all per ton delivered f.o.t. consumers' works.

Metals.

Copper.—Recent developments in the position of the market for warrant copper emphasise the outstanding strength still maintained, both in turnover and demand for the metal, which gives no immediate sign of receding from its present high levels. Although American interests are stated to be mainly responsible for this rise, there is no doubt that it is more than a temporary phase. Looking back into 1927 it will be seen that since then the trend of the market generally has been upward, and there has been no slackening off of the influences which caused it.

Closing quotations are :—

Cash.—Thursday, £97 10s. to £97 12s. 6d.; Friday, £97 to £97 2s. 6d.; Monday, £95 7s. 6d. to £95 10s.; Tuesday, £95 7s. 6d. to £95 8s. 9d.

Three Months.—Thursday, £98 7s. 6d. to £99; Friday, £98 7s. 6d. to £98 10s.; Monday, £96 12s. 6d. to £96 15s.; Tuesday, £96 15s. to £96 17s. 6d.

Tin.—An improving tone can also be noted with reference to standard tin values, and the demand, which had formerly been rather limited, has shown a tendency to revive somewhat, while American advices report a firmer tone in that country. It would appear that regular consumers have now decided that there is less risk in carrying sufficient supplies for the needs of a few weeks ahead than in carrying no supplies at all, and in consequence have been buying rather more freely of late.

Official closing prices :—

Cash.—Thursday, £222 15s. to £223; Friday, £223 12s. 6d. to £223 15s.; Monday, £220 12s. 6d. to £220 15s.; Tuesday, £220 to £220 5s.

Three Months.—Thursday, £223 2s. 6d. to £223 5s.; Friday, £223 to £223 5s.; Monday, £221 2s. 6d. to £221 5s.; Tuesday, £220 17s. 6d. to £221.

Spelter.—The demand for spelter continues fairly active, and values have advanced steadily. It is significant that, despite the heavy increases in production, no heavy stocks have accumulated, so that the demand has kept pace with the increased production. With regard to the future, indications of late have pointed to a more rapid increase in consumption, particularly in America.

Daily quotations are :—

Ordinary.—Thursday, £27 18s. 9d.; Friday, £27 16s. 3d.; Monday, £27 6s. 3d.; Tuesday, £27 10s.

Lead.—The market for soft foreign pig has shared with copper the sensation of the last week. Demand from consumers, which of late has been extraordinarily dull, suddenly revived, and with limited supplies available prices rose rapidly.

Prices have been :—

Soft Foreign Prompt.—Thursday, £28 12s. 6d.; Friday, £28 15s.; Monday, £26 12s. 6d.; Tuesday, £26 7s. 6d.

Reports and Dividends.

Henry Bessemer & Company, Limited.—Net profit, £24,344; brought in, £11,312; carried forward, £35,646.

Motherwell Iron and Steel Company, Limited.—Loss for year, £6,437; debit balance carried forward, £34,119.

English Crown Spelter Company, Limited.—Loss, £7,668; brought in, £3,766; debit balance carried forward, £3,900.

Vickers-Armstrongs, Limited.—Profit, £182,733; written off formation expenses, £12,968; to renewals fund, £105,000; carried forward, £64,765.

Thomas Robinson & Son, Limited.—Profit, £2,123; brought in, £28,310, dividend on the ordinary shares of 6d. per share, making 5 per cent. for year; carried forward, £8,986.

Rivet, Bolt & Nut Company, Limited. — Profit, £42,954; brought in, £10,885; depreciation, £10,893; dividend of 10 per cent., less tax, on the ordinary shares, £33,000; carried forward, £9,946.

Coltness Iron Company, Limited.—Final dividend of 2½ per cent., making 5 per cent. for the year, on the ordinary shares; to redemption and depreciation account, £45,000; carried forward, £118,512.

Hadfields, Limited.—Profit, £112,053; brought in, £86,366; debenture interest, £57,152; preference dividend, £13,500; dividend of 2½ per cent., less tax, on the ordinary shares; carried forward, £90,571.

Lancashire Dynamo and Motor Company, Limited.—Net profit, £21,002; brought in, £5,350; dividend of 5 per cent on the ordinary shares; directors' fees, £700; to reserve, £5,000; forward, £7,809.

Merry & Cuninghame, Limited.—Loss brought forward, £185,191; adverse balance for year, £34,860; debenture interest for half-year to May 31, 1928, £6,287; debit balance carried forward, £226,339.

British Insulated Cables, Limited.—Profit, £617,951; brought in, £305,880; depreciation, £100,000; to reserve, £299,966; dividend of 10 per cent. on the ordinary shares, making 15 per cent.; carried forward, £250,089.

Scottish Tube Company, Limited.—Balance at credit of profit and loss account, £1,523; brought in, £20,819; debenture interest, £812; transferred from reserve account, £15,000; preference dividend, £15,000; carried forward, £6,530.

Bruce Peebles & Company, Limited.—Profit, £1,140; brought in, £5,967; transferred from general reserve, £10,000; preference dividends, £3,830; dividend on the ordinary shares of 5 per cent., less tax, £8,123; carried forward, £5,154.

Vickers, Limited.—Balance of profit, after payment of debenture interest, £939,903; preference dividends, £418,190; brought in, £208,721; to reserve fund, £250,000; dividend of 8 per cent., less tax, on the ordinary shares, £262,730; carried forward, £217,704.

Scottish Iron and Steel Company, Limited.—Trading profit, £47,174; debenture interest, £119; depreciation allowance, £16,104; balance for year, £30,951; final dividend of 3 per cent., less tax, on the preference shares, making 6 per cent.; dividend of 5 per cent., less tax, on the ordinary shares. Balances of profit appropriation accounts carried forward: Preference shareholders, £12,930; ordinary shareholders, £1,395.

New Companies.

Letchworth Casting Company, Limited, The Foundry, Birds Hill, Letchworth.—Capital £2,000. Directors: H. G. Barrett, P. B. Broomhall, A. C. Furmston and J. Ray.

Hornsby & Goodwyn (Construction), Limited, Dawes Lane, Scunthorpe, Lincs.—Capital £7,000. Constructional engineers, etc. Directors: O. B. Leigh and H. Goodwin.

George Hatton & Company (Birmingham), Limited, Albion Works, Heath Street South, Birmingham.—Capital £5,500. Manufacturers of aluminium, etc. Director: M. Jacobs.

R. Goodman & Company, Limited, 19, High Street, Montrose.—Capital £2,000. Wire and metal merchants, etc. Directors: W. J. Reid, R. Goodman, J. Tindal and H. H. Soutar.

Lisburne Base Metals Recovery, Limited.—Capital £18,000 in 2s. shares. Directors: R. R. Nancarrow, C. S. Ralli and E. C. Powell. Secretary: T. L. Gruber, 38, Park Road, Chiswick, W.

Robert R. Paton (Incorporating Frank Munn), Limited.—Capital £7,000. Iron and steel merchants, etc. Directors: J. R. Paton, 27, Windsor Place, Cardiff (managing director), and G. H. Tyce.

1200 SIZES and TYPES of SIROCCO FANS

SOME "SIROCCO" CATALOGUES.

(4) *Centrifugal Fans*
(5) *High Pressure Fans*
(6) *Dust Fans*
(7) *Propeller Fans*
(18) *Mechanical Boiler Draught*

are listed by us. One of these will exactly suit your particular Fan requirement and give you entire satisfaction with years of hard service.

Submit your Fan problems to us.

DAVIDSON & CO. LIMITED.
Sirocco Engineering Works.
BELFAST

THE HOPE WORKS CO.

ESTABLISHED 1859.

HOPE STREET,——————DUDLEY

MANUFACTURERS of Every Description of
FOUNDRY REQUISITES
SMITHS' & TINMANS' TOOLS
ASK FOR CATALOGUES.

WEEKLY PRICE CURRENT.

COPPER.

	£	s.	d.
Standard cash	95	7	6
Three months	96	15	0
Electrolytic	111	10	0
Tough	105	0	0
Best selected	105	0	0
Sheets	138	0	0
India	129	0	0
Wire bars	112	12	6
Do. April	112	12	6
Do. May	112	12	6
Ingot bars	112	12	6
H.C. wire rods	112	10	0
Off. av. cash, February	78	5	10¼
Do. 3 mths., February	78	4	10⅞
Do., Sttlmnt., February	78	5	6
Do., Electro, February	83	18	4½
Do., B.S., February	81	18	1½
Aver. spot price, copper, Feb.	78	5	10¼
Do. wire bars, February	84	6	0
Solid drawn tubes			18¼d.
Brazed tubes			18½d.
Wire			14½d.

BRASS.

Solid drawn tubes	15½d.
Brazed tubes	17½d.
Rods, drawn	13⅞d.
Rods, extd. or rlld.	9d.
Sheets to 10 w.g.	13⅛d.
Wire	12⅞d.
Rolled metal	12⅞d.
Yellow metal rods	9d.
Do. 4 × 4 Squares	10d.
Do. 4 × 3 Sheets	10½d.

TIN.

	£	s.	d.
Standard cash	220	0	0
Three months	220	17	6
English	220	12	6
Bars	222	12	6
Straits	222	2	6
Australian	222	2	6
Eastern	225	15	0
Banca	223	17	6
Off. av. cash, February	223	4	8½
Do., 3 mths., February	224	3	11½
Do., Sttlmt., February	223	3	9
Aver. spot, February	223	4	8½

SPELTER.

Ordinary	27	10	0
Remelted	26	5	0
Hard	22	0	0
Electro 99.9	30	5	0
English	27	15	0
India	22	0	0
Zinc dust (Nom.)	30	0	0
Zinc ashes	9	0	0
Off. aver., February	26	5	11½
Aver., spot, February	26	4	11½

LEAD.

Soft foreign ppt.	26	7	6
English	28	0	0
Off. average, February	23	2	10½
Average spot, February	23	2	6¼

ZINC SHEETS, &c.

Zinc sheets, English	36	0	0
Do. V.M. ex whf.	35	7	6
Rods	46	0	0
Boiler plates	34	0	0
Battery plates	34	15	0

ANTIMONY.

Special brands, Eng.	54	10	0
Chinese	38	10	0
Crude	33	10	0

QUICKSILVER.

Quicksilver	22	3	9

FERRO-ALLOYS AND STEEL-MAKING METALS.

Ferro-silicon—			
25%	7	17	6
45/50%	12	0	0
75%	19	10	0

Ferro-vanadium—	
35/50%	13/9 lb. Va.
Ferro-molybdenum—	
70/75% c. free	3/8 lb. Mo.
Ferro-titanium—	
23/25% carbonless	11d. lb.
Ferro-phosphorus, 20/25%	£16 10 0
Ferro-tungsten—	
80/85%, c. fr.	1/10½ to 1/11 lb.
Tungsten metal powder—	
98/99%	2/0½ lb.
Ferro-chrome—	
2/4% car.	£33 0 0
4/6% car.	£28 17 6
6/8% car.	£22 10 0
8/10% car.	£22 10 0
Ferro-chrome—	
Max. 2% car.	£34 0 0
Max. 1% car.	£35 10 0
Max. 0·70% car.	£40 10 0
70%, carbonless	1/2 lb.
Nickel—99%, cubes or pellets	£175 0 0
Ferro-cobalt	9/3 lb.
Aluminium 98/99%	£95 0 0
Metallic chromium—	
96/98%	2/6 lb.
Ferro-manganese (net)—	
76/80% loose	£13 15 0
76/80% packed	£14 15 0
76/80%, export	£14 10 0
Metallic manganese—	
94/96%, carbonless	1/6 lb.

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

Finished bars, 14% tungsten	£0 2 0
Finshed bars, 18% tungsten	£0 2 9

Per lb. net, d/d buyers' works.

Extras—

Rounds and squares, 3 in. and over	4d. lb.
Rounds and squares, under ½ in. to ¼ in.	3d. lb.
Do., under ¼ in. to $\frac{7}{16}$ in.	1/- lb.
Flats, ½ in. × ¼ in. to under 1 in. × $\frac{3}{8}$ in.	3d. lb.
Do., under ½ in. × ¼ in.	1/- lb.
Bevels of approved sizes and sections	6d. lb.

Bars cut to length, 10% extra

SCRAP.

South Wales—	£	s.	d.		£	s.	d.
Heavy steel	3	15	0	to	3	17	6
Bundled steel and shrngs.	3	8	0	to	3	15	0
Mixed iron and steel	3	8	0	to	3	10	0
Heavy cast iron					3	5	0
Good machinery for foundries	3	5	0	to	3	7	6

Cleveland—							
Heavy steel					3	3	6
Steel turnings					2	14	6
Cast iron borings					2	10	0
Heavy forge					3	15	0
W.I. piling scrap					3	10	0
Cast-iron scrap	3	2	6	to	3	6	0

Lancashire—							
Cast-iron scrap	2	15	0	to	3	10	0
Hvy. wrought					3	12	6
Steel turnings					2	12	6

Scotland—							
Heavy steel					3	13	0
Cast-iron borings					2	16	6
Wrought-iron piling					3	11	3
Heavy machinery					3	12	6

London—Merchants' buying prices delivered yard.

Copper (clean)	70	0	0
Brass	45	0	0
Lead (less usual draft)	24	0	0
Tea lead	22	0	0
Zinc	19	0	0
New aluminium cuttings	67	0	0
Braziery copper	64	0	0
Gunmetal	60	0	0
Hollow pewter	160	0	0
Shaped black pewter	105	0	0

PIG-IRON.

(f.o.t. unless otherwise stated.)

N.E. Coast—	
Foundry No. 1	69/6
Foundry No. 3	67/-
Foundry No. 4	66/-
Forge No. 4	65/6
Hematite No. 1	74/-
Hematite M/Nos.	73/6
N.W. Coast—	
Hem. M/Nos. d/d Glas.	81/6
„ d/d Birm.	89/6
Midlands—	
Staffs. common*	—
„ No. 4 forge*	71/-
„ No. 3 fdry*	75/-
Shrops. basic	—
„ Cold blast, ord.	—
„ „ roll iron	—
Northants forge*	65/-
„ fdry. No. 3*	69/-
Derbyshire forge	59/-
„ fdry. No. 3	60/- to 62/6
„ basic	65/-

* d/d Black Country dist.

Scotland—	
Foundry No. 1	75/-
„ No. 3	72/6
Hem. M/Nos.	76/-
Sheffield (d/d district)—	
Derby forge	64/-
„ fdry. No. 3	66/-
Lincs. forge	63/6
„ fdry. No. 3	67/6
E.C. hematite	84/-
W.C. hematite	86/-
Lincs. (at furnaces)—	
Forge No. 4	59/-
Foundry No. 3	63/-
Basic	63/-
Lancashire (d/d eq. Man.)—	
Derby forge	—
„ fdry. No. 3	71/-
Northants foundry No. 3	—
Dalzell, No. 3 (special)	100/- to 102/6
Summerlee, No. 3	90/-
Glengarnock, No. 3	90/-
Gartsherrie, No. 3	90/-
Monkland, No. 3	90/-
Shotts, No. 3	90/-

FINISHED IRON AND STEEL.

Usual District deliveries for iron; delivered consumers' station for steel.

Iron—	£	s.	d.	£	s.	d.
Bars (cr.) nom.				10	5	0
Nut and bolt iron	8	15	0	9	0	0
Hoops				11	10	0
Marked bars (Staffs.) f.o.t.				12	0	0
Gas strip				11	10	0
Bolts and nuts, ¾ in. × 4 in.				15	5	0

Steel—							
Ship plates	8	7	6	to	8	12	6
Boiler plts.					10	10	0
Chequer plts.					10	12	6
Angles					7	17	6
Tees					8	17	6
Joists					7	17	6
Rounds and squares, 3 in. to 5½ in.					8	17	6
Rounds under 3 in. to ¾ in. (Untested)					7	15	0
					and upwards		
Flats, over 5 in. wide and up					8	7	6
Flats, 5 in. to 1½ in.					7	17	6
Rails, heavy					8	10	0
Fishplates					12	10	0
Hoops (Staffs.)	10	10	0	to	11	0	0
Black sheets, 24g.	10	0	0	to	10	10	0
Galv. cor. shts., 24g.	13	10	0	to	13	15	0
Galv. fencing wire 8g. plain					11	10	0
Billets, soft	6	5	0	to	7	0	0
Billets hard	7	5	0	to	8	0	0
Sheet bars	6	0	0	to	6	6	6
Tin bars	6	0	0	to	6	6	6

PHOSPHOR BRONZE.

	Per lb. basis.
Strip	1/6
Sheet to 10 w.g.	1/7
Wire	1/8½
Rods	1/7
Tubes	2/-
Castings	1/6

Delivery 3 cwt. free.
10% phos. cop. £40 above B.S.
15% phos. cop. £50 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. CLIFFORD & SON, LIMITED.

NICKEL SILVER, &c.

	per lb.
Ingots for raising	10d. to 1/4
Rolled—	
To 9 in. wide	1/4 to 1/10
To 12 in. wide	1/4½ to 1/10½
To 15 in. wide	1/4½ to 1/10½
To 18 in. wide	1/5 to 1/11
To 21 in. wide	1/5½ to 1/11½
To 25 in. wide	1/6 to 2/-
Ingots for spoons and forks	10d. to 1/6½
Ingots rolled to spoon size	1/1 to 1/9½
Wire round—	
3/0 to 10 G.	1/7½ to 2/2½

with extras according to gauge.

AMERICAN IRON AND STEEL.

At Pittsburgh unless otherwise stated.

	Dols.
No. 2X foundry, Phila.	21.26
No. 2 foundry, Valley	18.00
No. 2 foundry, Birm.	16.50
Basic	19.26
Bessemer	20.79
Malleable	20.01
Grey forge	19.26
Ferro-mang. 80% d/d	105.00
O.-h. rails, h'y at mill	43.00
Bess billets	34.00
O.-h. billets	34.00
O.-h. sheet bars	35.00
Wire rods	42.00
	Cents.
Iron bars, Phila.	2.12
Steel bars	1.95
Tank plates	1.90
Beams, etc.	1.90
Skelp, grooved steel	1.90
Skelp, sheared steel	1.90
Steel hoops	2.20
Sheets, black, No. 24	2.85
Sheets, galv., No. 24	3.60
Sheets, blue an'l'd, 9 and 10	2.10
Wire nails	2.65
Plain wire	2.50
Barbed wire, galv.	3.30
Tinplates, 100 lb. box	$5.35

COKE (at ovens).

Welsh foundry	25/-
„ furnace	19/- to 22/6
Durham and North.	
„ foundry	20/-
„ furnace	16/6
Midlands, foundry	—
„ furnace	15/6

TINPLATES.

f.o.b. Bristol Channel ports.

I.C. Cokes	20×14 box	18/-
„	28×20 „	36/-
„	20×10 „	26/3
„	18¾×14 „	18/9
C.W.	20×14 „	15/-
„	28×20 „	33/6
„	20×10 „	21/3
„	18¾×14 „	15/-
Terneplates	28×20	33/6 per box basis f.o.b.

SWEDISH CHARCOAL IRON & STEEL.

Pig-iron	£6	0	0	to	£7	10	0	
Bars, hammered, basis	£17	10	0	to	£18	10	0	
Bars and nail-rods, rolled, basis	£15	15	0	to	£16	15	0	
Blooms	£10	0	0	to	£12	0	0	
Keg steel	£32	0	0	to	£33	0	0	
Faggot steel	£20	0	0	to	£24	0	0	
Bars and rods, dead soft, steel	£10	0	0	to	£14	0	0	

All per English ton, f.o.b. Gothenburg.

TUBES AND FITTINGS.

Up to and incl. 6 in.

	Tubes.	Fittings.
Gas	67½%	50%
Water	63½%	45%
Steam	60%	40%

W.I. 10% extra.

DAILY FLUCTUATIONS.

Standard Copper (cash).

		£	s.	d.		
Mar.	21	97	10	0	inc.	25/-
,,	22	97	0	0	dec.	10/-
,,	25	95	7	6	,,	32/6
,,	26	95	7	6	No change	

Electrolytic Copper.

		£	s.	d.		
Mar.	21	107	10	0	inc.	100/-
,,	22	107	10	0	No change	
,,	25	111	12	6	inc.	82/6
,,	26	111	10	0	dec.	2/6

Standard Tin (cash).

		£	s.	d.		
Mar.	21	222	15	0	No change	
,,	22	223	12	6	inc.	17/6
,,	25	220	12	6	dec.	60/-
,,	26	220	0	0	,,	12/6

Tin (English ingots).

		£	s.	d.		
Mar.	21	222	15	0	dec.	25/-
,,	22	223	10	0	inc.	15/-
,,	25	220	12	6	dec.	57/6
,,	26	220	12	6	No change	

Zinc Sheets (English).

		£	s.	d.		
Mar.	21	36	0	0	inc.	40/-
,,	22	36	0	0	No change	
,,	25	36	0	0	,,	,,
,,	26	36	0	0	,,	,,

Spelter (ordinary).

		£	s.	d.		
Mar.	21	27	18	9	dec.	7/6
,,	22	27	16	3	,,	2/6
,,	25	27	6	3	,,	10/
,,	26	27	10	0	inc.	3/9

Lead (English).

		£	s.	d.		
Mar.	21	30	0	0	inc.	10/-
,,	22	30	5	0	,,	5/-
,,	25	28	10	0	dec.	35/-
,,	26	28	0	0	,,	10/-

AVERAGE MONTHLY PRICES OF STEEL BOILER PLATES IN ENGLAND.

Year.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Yearly average.
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
1895	5 15 0	5 15 0	5 12 6	5 12 6	5 15 0	5 17 6	5 15 0	5 17 6	6 0 0	6 0 0	6 2 6	6 0 0	5 16 10½
1896	6 0 0	6 0 0	6 2 6	6 2 6	6 2 6	6 0 0	6 0 0	6 0 0	6 0 0	6 2 6	6 10 0	6 10 0	6 2 6
1897	6 10 0	6 10 0	6 10 0	6 7 6	6 2 6	6 2 6	6 5 0	6 0 0	6 0 0	6 0 0	6 7 6	6 10 0	6 5 5
1898	6 10 0	6 8 9	6 8 9	6 10 0	6 15 0	6 18 9	6 17 6	6 17 6	7 2 6	6 15 0	7 0 0	7 5 0	6 15 8½
1899	7 5 0	8 0 0	8 2 6	8 2 6	8 5 0	8 5 0	8 12 6	8 12 6	8 15 0	8 15 0	9 2 6	9 5 0	8 17 8½
1900	9 5 0	9 5 0	9 7 6	9 10 0	9 12 6	10 5 0	10 5 0	10 5 0	10 5 0	10 0 0	9 15 0	9 15 0	9 15 10
1901	9 5 0	9 5 0	8 15 0	8 10 0	8 10 0	7 10 0	7 15 0	7 15 0	7 15 0	7 15 0	7 15 0	7 15 0	8 3 11
1902	7 7 6	7 0 0	7 12 6	7 12 6	7 12 6	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 9 7
1903	7 10 0	7 10 0	7 15 0	7 5 0	7 5 0	7 5 0	7 5 0	7 0 0	7 0 0	7 0 0	7 0 0	6 17 6	7 3 11½
1904	6 12 6	6 15 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	6 18 11½
1905	6 17 6	6 17 6	6 17 6	6 17 6	6 17 6	6 17 6	6 17 6	6 17 6	6 10 0	7 5 0	8 0 0	8 0 0	7 1 3
1906	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 10 0	8 0 10
1907	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 0 0	8 0 0	8 8 4
1908	7 10 0	7 10 0	7 10 0	7 5 0	7 5 0	7 5 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 3 9
1909	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	6 15 0	6 15 0	6 15 0	7 0 0	7 0 0	7 0 0	7 0 0	6 18 9
1910	7 0 0	7 0 0	7 1 3	7 5 0	7 5 0	7 5 0	7 5 0	7 5 0	7 5 0	7 10 0	7 10 0	7 10 0	7 5 1
1911	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 14 0	7 10 4
1912	7 18 9	8 0 0	8 0 0	8 7 6	8 10 0	8 10 0	8 10 0	8 15 0	8 16 3	9 0 0	9 2 0	9 5 0	8 11 2½
1913	9 5 0	9 5 0	9 5 0	9 5 0	9 5 0	9 5 0	9 5 0	8 19 0	8 15 0	8 5 0	7 15 0	7 15 0	8 17 0
1914	7 15 0	7 15 0	7 15 0	7 13 9	7 10 6	7 5 0	7 0 0	8 0 0	8 2 6	8 5 0	8 5 0	8 5 0	7 15 11½
1915	8 14 0	9 10 0	9 17 6	10 10 0	10 10 0	11 0 0	11 0 0	11 0 0	11 0 0	11 4 0	12 0 0	13 0 0	10 15 5½
1916	13 0 0	13 0 0	13 0 0	12 15 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 12 11
1917	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0
1918	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0
1919	13 0 0	15 0 0	15 0 0	15 0 0	19 5 0	19 17 6	21 0 0	21 10 0	21 10 0	21 10 0	21 15 0	23 10 0	18 9 9
1920	26 0 0	28 0 0	28 5 0	28 10 0	29 5 0	30 0 0	30 0 0	30 10 0	30 10 0	31 0 0	31 0 0	31 0 0	29 9 2
1921	30 5 0	29 0 0	25 0 0	25 0 0	25 0 0	23 0 0	21 0 0	20 10 0	19 0 0	17 10 0	16 0 0	14 16 0	22 1 9
1922	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	13 1 8	13 10 0	12 15 0	12 10 0	12 10 0	12 10 0	12 6 0	13 10 9
1923	12 8 9	13 6 0	14 0 0	14 0 0	14 0 0	14 0 0	13 12 6	13 0 0	13 0 0	13 0 0	13 0 0	13 10 0	13 9 1½
1924	13 10 0	13 10 0	13 10 0	13 10 0	13 10 0	13 10 0	13 10 0	14 0 0	14 0 0	13 11 0	13 5 0	13 5 0	13 10 11
1925	13 5 0	13 5 0	13 5 0	13 1 0	12 15 0	12 15 0	12 15 0	12 15 0	12 7 8	11 14 0	11 10 0	11 10 0	12 11 5½
1926	11 10 0	11 10 0	11 10 0	11 5 0	11 5 0	11 5 0	11 5 0	11 5 0	11 5 0	11 5 0	11 5 0	11 5 0	11 6 3
1927	11 5 0	11 5 0	11 5 0	11 5 0	11 2 6	11 0 0	11 0 0	11 0 0	10 16 0	10 10 0	10 10 0	10 10 0	10 19 0½
1928	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0
1929	10 10 0	10 10 0	10 10 0	—	—	—	—	—	—	—	—	—	—

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(A remittance should accompany instructions.)

SITUATIONS VACANT AND WANTED.

METALLURGICAL CHEMIST, with 10½ years' experience of electric furnace work; present position Metallurgist to firm of steel, iron and brass founders and engineers, requires similar position with larger firm, or that of steel foundry manager. — Box 168, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

FOUNDRY MANAGER seeks engagement; 15 years' experience, possessing wide knowledge manufacture high-grade castings for all engineering purposes (especially Diesel); well versed machine moulding and modern foundry methods for quality production; accustomed drawings, estimating, and capable taking full charge all departments; first-class technical training; best references; willing invest small capital. — Box 174, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

MANAGER required for Foundry in Cardiff. Directorship given to one able to invest and introduce business.—Apply, Box 172, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

AGENCIES.

AGENTS wanted for Scotland, Lancs, Westmorland and Cumberland, Midlands, South Wales, North Wales, to handle Chain Belting on commission basis; good opportunity for those calling on collieries, quarries, engineering and gas works.—Pennine Chainbelt Company, Limited, Spencer Road, Lidget Green, Bradford.

ADVERTISER, with good connection amongst engineers, grey and malleable iron and brass founders, is desirous of representing, on commission basis, in the Midlands area, one or two firms manufacturing foundry specialities, etc., etc.—Box 178, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

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A TRAFFORD PARK BARGAIN.—Modern Foundry with own railway sidings, excellent warehouse, packing room and fine offices, centrally heated, for SALE. Premises are all one storey and easily adaptable for other trades. Cost £20,000 in 1921. For a quick sale, owners will take £2,000.—F. S. Airey, Entwistle & Company, 10, Norfolk Street, Manchester.

MACHINERY.

SAND MIXERS.—New and second-hand. Ask us to quote.—W. Brealey & Company, Limited, Prospect Works, Hawksley Avenue, Sheffield.

MACHINERY—*Continued.*

TILGHMAN SAND-BLAST ROOM PLANT, 12 ft. x 9 ft. x 8 ft. high, complete with cyclone, separator, air receiver and piping, etc., all as new, £290 net, including enclosed vertical compressor.—Box 166, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

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NEW 8-in. Centres Relieving Lathe, on 4-ft. 3-in. bed.
BRYANT No. 6 Chucking Grinder, chuck range 12 in., max. grinding length 9 in.
Three 2-cwt. Drop Hammers, by ALLDAYS.
No. 2 LAPOINTE Broaching Machine, width of cutter bars ⅞ in.
Two LANCASHIRE BOILERS, 30 ft. x 8 ft., re-insure 110 lbs. pressure.
LANCASHIRE BOILER, 30 ft. x 8 ft., re-insure 100 lbs. pressure.
8-b.h.p. PETROL-DRIVEN WINCH (Keighley Gas & Oil Engine Company), to lift about 12/15 cwts. at 70 ft. per minute.
THIRTY (30) HORIZONTAL DOUBLE-GEARED STEAM WINCHES (Clarke Chapman), cyls. 4½ in. diam. x 6-in. stroke; drum 22 in. diam. x 20-in. wide; brake.
(ASK FOR "ALBION" MACHINERY CATALOGUE.)
THOS. W. WARD, LTD.,
ALBION WORKS, SHEFFIELD.

FOR SALE, CUPOLA, 2-ton per hour, complete with 100 sq. ft. staging with steps for same, steel pillars, Keith Blackman fan and motor, ladle and shanks. Cheap proposition, suitable for foundry just commencing business.—Write, Box 176, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

WHY NOT change your method—increase production in your foundry, improve the accuracy of your castings, reduce costs in foundry and pattern-shop, with a "Perfect Core" Machine? Inquiries invited.—Ralph Wilson, Cobden Street, Wednesbury.

PATENT.

THE proprietors of British Patents Nos. 157165 and 157167 relating to "Improvements in Rolling Mills" desire to enter into negotiations with one or more firms in Great Britain for the sale of the Patent rights or for the grant of Licences to manufacture under royalty.—Inquiries to be addressed to D. Young & Company, Chartered Patent Agents, 11 and 12, Southampton Buildings, London, W.C.2.

MISCELLANEOUS.

ONE of the most prominent and successful AMERICAN MANUFACTURERS of MOULDING MACHINES desires to negotiate with a British Engineering establishment having manufacturing and marketing facilities for this type of business.—Apply, Box 1849, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

FOR SALE.—Du-Ram Patent Steel Moulding Boxes, as used by all the leading foundries. Perfect interchangeability and accuracy together with long life. Inquiries solicited. Quick deliveries.—J. W. Sadler & Company, Limited, Bartle Lane, Great Horton, Bradford.

CHARCOAL.—Powdered, granulated, lump, blacking; inquiries invited.—J. Buchanan & Company, Ashfield Road, Altrincham, Cheshire.

500 TWILL POCKETS, 14 x 21 in., at 2¼d. each; 1,000 Twill Pockets, 16 x 26 in., at 2¾d. each; others suitable for Foundry trades. —Bidder Street Mills, Canning Town, E.16.

MISCELLANEOUS—*Continued.*

PATTERNS.—Inquiries solicited; quotations by return; shop equipped with modern machinery; quick delivery.—Gleghorn & Company, Midland Pattern Works, Spring Gardens, Worcester. 'Phone 264.

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COGAN STREET,
HULL.

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HIGHCROSS STREET, LEICESTER.

BRASSFOUNDRY RESIDUES. — Ashes, Skimmings, Grindings, Dust, bought for best prices; collected by lorry radius 30 miles London, or ex rail beyond.—Communications, Kinrix, 199-201, Warwick Road, London, W.14. 'Phone: Western 0273.

3,000 HEAVY TWILL BAGS, 20 in. x 28 in., 3½d. each; 1,500 smaller ditto, 14 in. x 21 in., 2½d. each; carriage paid. Bidder Street Mills, Canning Town, London, E.16.

GANISTER, best quality, for cupolas, also for Steel Works.—Astbury Silica Company, "The Brooms," Park Lane, Congleton.

FLUORSPAR.—The ideal Flux for all Foundry and Furnace work; supplied in crude lump, washed gravel or finely ground. Samples and prices from
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15 Ton STEVENSON (as New)	£65
10 Ton EVANS (as New)	£48
8 Ton EVANS (as New)	£42
5 Ton EVANS (as New)	£35
4 Ton EVANS (as New)	£30
2 Ton JACKMAN (as New)	£24
1 Ton New (enclosed gear)	£19

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